DOCUMENT RESUME

ED 316 181 IR 014 140

AUTHOR	Collins, J. H., Ed.; And Others
TITLE	Proceedings of the International Conference on Technology and Education (5th, Edinburgh, Scotland, March 1988). Volume 1.
SPONS AGENCY	Tandy Corp., Ft. Worth, TX. Radio Shack Education Div.
REPORT NO	ISBN-0-905941-26-8
PUB DATE	Mar 88
NOTE	638p.; For Volume 2, see IR 014 141; for the proceedings of the sixth conference, see IR 014 142-143.
PUB TYPE	Collected Works - Conference Proceedings (021) -- Reports - Descriptive (141) -- Reports - Research/Technical (143)
EDRS PRICE	MF03/PC26 Plus Postage.
DESCRIPTORS	*Administration; *Artificial Intelligence; *Computer Assisted Instruction; Disabilities; *Distance Education; *Educational Technology; Elementary Secondary Education; Higher Education; Interactive Video; Leadership; Open Education; *Teacher Education; Technology Transfer; Telecommunications

ABSTRACT

The first of two volumes in these proceedings contains the text (or, in a very few cases, an abstract) of 157 papers on the use of technology at all levels of education, including elementary, secondary, and higher education. These papers were presented in 54 topic sessions and two plenary sessions. Themes of the sessions include: (1) educational administration and leadership; (2) enabling technologies; (3) using computers to enhance instruction; (4) artificial intelligence; (5) open and distance learning; (6) teacher education; and (7) using computers with the handicapped. An alphabetical index of authors in this volume is provided. (GL)

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The Fifth International Conference On Technology And Education

Volume 1

Edinburgh – March 1988

IR014140

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The Fifth
International Conference
On
Technology And Education

Volume 1

Edinburgh – March 1988

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J H Collins
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D Walker

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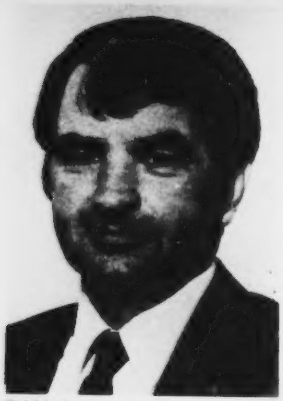
Published by CEP Consultants Ltd, 26–28 Albany Street, Edinburgh EH1 3QH, UK

Printed in Great Britain by Page Bros (Norwich) Ltd.

J H Collins

N Estes



D Walker

INTRODUCTION

As we race towards the 21st century and the full dawning of the information age, societies around the world face a most serious challenge: the widening gap between the complexity of world problems and the capacity of individuals and societies to solve them. Education, as never before, has been called upon to develop the full potential of the human resource, to prepare the leaders and the youth of tomorrow to be both information and knowledge rich.

The Fifth International Conference on Technology and Education has answered this challenge by facilitating the exchange of information and technical expertise among the participating nations in the areas of research, application, and the development of more productive and innovative approaches to learning.

These conference proceedings report on a series of themes ranging from artificial intelligence to classroom teacher experiences. The papers focus on all levels of education including primary, secondary, and higher education.

The conference and these proceedings represent a tremendous commitment of time and energy from those who worked on the organising and the planning of this conference. We wish to express our appreciation for the support and expertise extended by the following individuals:

William Gattis, Tandy Corporation/Radio Shack Education Division, USA
Paul Resta, International Council for Computers in Education
Peter Ross, University of Edinburgh, UK
David Semple, Lothian Regional Council, Edinburgh, UK

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PUPILS - PANACEAS AND PRAGMATISM

J.F. Foster*

ABSTRACT

There are problems in getting a balanced view of the roles of the computer in education. These can include the too ready use of the computer for trivial tasks as well as teachers' unpreparedness to adopt computer related methods even where they appear to be obvious and most attractive.

This paper addresses the need for the consideration of strategies to get the computer integrated into the learning process through all ages and stages of learning. It considers the rights of the learner to exposure to the seductive power of the new technologies and the wide experiences that are possible which assist the learning process - and the essential need to expose the learner to the full potential of the new technologies.

INTRODUCTION

As a profession we are usually slow to adapt to change. We are very bad at telling our clients what we are up to. However, there is, it seems, always something that some of us are shouting about. Something that is "in vogue" will engage the attention of the few, who, like the monkey without a tail, rush around trying hard to convince their colleagues that theirs is the way of life that all should adopt for their own good. Mostly no one listens. Just occasionally the few become many and the trend becomes too big to ignore. It gets seized by the media, exploited by the politicians. If the public, our clients, get hold of the ideas they may start to want them for their children - but because we haven't bothered to tell them much about what we are trying to do, they may want them for quite the wrong reasons or reject them through ignorance or media generated prejudice. Colleagues begin to feel guilty if they are not engaged in the new ways or they stubbornly resist them, hoping that the trend, like other trends, will pass. It seems that now new trends come around more quickly than they did and, because we are in this era of mass communication, they spread more widely and faster.

As a profession we have to learn to recognise fools and fools' gold. Are we the peddlers of the computer as the panacea of all educational ills? Do we proselytise our colleagues from a position that is well thought out and unassailable? Are we being conned? How can we be sure? Are we able to deliver the "new Jerusalem" we are trusting in? Where on earth do we go from here?

THE COMPUTER REVOLUTION

It is always easier at the beginning of change. Back in the '70s few of us could have access to a computer, even if we wanted it.

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The few that could were usually hobbyists, using their enthusiasm to persuade their schools of the need to buy them equipment or bringing in their own machines, often kit assembled. Sometimes the local authority or School Board plumbed schools into spare capacity on a local mainframe - teletypes chattering back the results of batch processing classes' assignments. The objectives were largely that (some) children should get experience/learn about the new technologies. There were claims for programming as the Latin of the twentieth century ("it trains the mind") and the computer became something for the few to study: its history, its industrial archeology, its social impact, its architecture - and programming. Almost by accident, it seems now, CBL, CAI, CML, CAD, CAL and probably a dozen more sets of initials began being banded about (there were arguments between officianados as to what was which). We were into the regime of "have solution now - need problem to match". Amazingly trivial tasks were given to computers. Often the easiest of things to teach, or that bit of real experience so essential for the development of concepts was relegated to the computer. The easy was made complex; the obvious obscure. The machine that was showing, in its better moments, a rare power of seducing young minds, allowing them to perform above our expectations of their abilities, risked being killed off by over selling as a cure-all; that the "in set" would succeed in making it all so complicated that only the few, resolute enough to cut through the jargon and determined enough to understand the handbooks and documentation written exclusively for the cognoscenti, would be able to join the club; that the computer "movement" would be tarred with all the excesses of the teaching machine movement and with all its problems of incompatibility and of hardware fragility. Just in time came National Programmes - in the UK the SMDP (the Scottish Microelectronics Development Programme) and the MEP (the Microelectronics Education Programme). A grip was taken. Advice was at hand. Money was spent. Policies were assembled. At the same time, computers became cheaper and infinitely easier to use. Colour appeared on screens. Peripherals proliferated. Objectives were discussed. Teachers were trained and had software written for them.

NATIONAL PROGRAMMES

These were heady days. We rushed headlong into our enthusiasm. For the educational technologists amongst us, at last we had a system that could make possible our ideas of learners taking a greater responsibility for their own learning, of children learning at their own pace, of alternative routes to learning goals. I have never known so dramatic and so speedy an uptake of new ideas as came with the availability of computers and of all that they delivered. For once we were marching in step with the objectives of our political paymasters. Change felt good. Classrooms were exciting.

The first phase of the UK programmes lasted about five years. They created awareness to some level in every school in the country. Of course by no means every teacher was set on fire. It was just as well they were not. Although a lot of computers were bought, with pump priming by our Department of Trade and Industry, there were (and are) still nowhere near enough of them to have been able to satisfy every teacher or even every classroom. There was insufficient inservice training and what there was far to often was more concerned with how rather than why and when to use computers. The programs were (and are) too often self contained with no guidance as to how they can be integrated into the curriculum. Teachers were being asked, often untrained, to take on learning management roles - and with perhaps only one machine available for a whole class of children. ("Should the computer be used only for the very bright/the very dull?"; " How do I stop them queuing up?"; "It's crashed again!"; "Well done! You have finished that work so you can go and use the computer").

Sometimes through pragmatism (though sometimes through design) teachers discovered the value of collaborative work at the computer. Especially in the Primary School, more used to this kind of working and anyway more prepared to experiment, teachers were finding the added value of language development by grouping threes and fours to a keyboard and it meant that the "turn" at the computer could be longer and it came round more frequently. They made up workcards which allowed the computer to become more than a memorable interlude in the "proper" work of the day (but the children still told their parents that they had been "playing with computers to-day"). In the better classrooms the computer was becoming integrated into the curriculum. It was used, as a scarce tool, only where it had something special to contribute.

The curriculum panels of the national progammes wrestled with the role of the computer in their subjects. Each subject wanted this seductive weapon in its armoury. Sometimes it was dragged into use at any price. It was becoming fashionable to talk about "learning with and not learning about the computer". "Computer Studies", examined at 16 years was losing its popularity (not with the parents or with the pupils who had opted for it successfully - an option always oversubscribed) but it was seen to be sapping the school's computer provision; too much demand from too few children. Shortened programmes of "computer literacy" or "awareness" began taking its place. It meant more pupils got their "hands-on experience" (and so fewer parents complained about their children not being allowed to do computer studies, seen by the million as a passport to a job if not to wealth and happiness ever after). It was also partly about the scarcity of trained computer studies teachers.

In April 1986, when MEP had been closed down, my unit, the Microelectronics Education Support Unit (MESU) began to be formed. (We have been more or less fully staffed since January 1987). By this time the local authorities had taken over many of the roles and much of the support provided by MEP. MEP had set up Regional Information Centres, fourteen of them, to service the education authorities of England, Wales and Northern Ireland. Now, with MEP closed, many LEAs had their own support services. Some had formed collectives to maintain with joint finance some or all of the MEP centres services. In all regions the LEA advisers continue to meet across authority boundaries to plot mutual support. MESU was formed to give the authorities of England, Wales and Northern Ireland the sort of support that comes sensibly on a national basis. Our remit tells us to provide support for the LEAs and to the institutions for initial teacher training by providing them with information and supporting their staff development training. We are to continue the work started by MEP in support of Special Education - through the network of the Special Education Microelectronics Resource Centres (SEMERCs) set up by MEP - until April 1989 (when most of their functions must be taken over by the LEAs) and then to provide from the Unit the support sensibly provided by a national unit. We are required to consolidate the work started by MEP and develop from there. This often means commissioning materials for the classroom around existing computer programs, that help their integration into the learning going on and give guidance to the teacher on the management issues assumed.

We have built our philosophy around a determination to promote and spread good practice, making sure that the work we commission others to do has its origins in the needs defined by our main clients, the LEA advisers and the initial teacher trainers. My staff spends a great deal of time listening - in conferences, with our designated contacts in the LEAs and colleges, with the teacher unions, with the specialist subject and phase associations. Reports are written. Consensus on needs is sought. Typical of the kind of things we are asked for are: **video case studies** showing good (transferable) classroom practice; materials and ideas which will strengthen (create) **primary to secondary continuity of experience in the use of information technology** across the curriculum; work to help the **portability of software** between machines; almost anything that puts the **computer into a curriculum context** etc.

Having got ideas agreed by our Management Board we go out to tender and by this and other means we place work around the country. We have criteria which have to be satisfied in the placing of this work and we try to achieve a balance, both between the different subjects in the curriculum and the phases of education but also in the geographical spread of our projects.

All this is now going to be helped by a new phase of government intervention. From April, 1988 the Department of Education and Science and the Welsh Office are encouraging LEAs through the "Rate Support Grant" (the mechanism by which central government adds funds to the LEAs) to spend money on new computers and on advisory teachers. In England alone this will account for a spend of £19 million pounds of which some eight and a half million will be spent on creating about six hundred and twenty advisory teachers who will be in post for two years. They are to be recruited from teachers with expertise in an aspect or a phase of the curriculum (rather than in information technology) and the aim is that this will encourage a sensible spread of IT across the curriculum. With the LEAs themselves, we will have the task of training and supporting these advisory teachers. As well as the training, we will give them collections of materials - video case studies, information packs, software and curriculum materials - to use with the teachers and children in the schools they are to support and in their own in-service training. The support they will give directly to teachers will, I feel sure, provide us with the most successful strategy so far. Eventually information technology will be used appropriately across the curriculum and we will be able to ensure every child gets more than just random exposure to the new technologies.

Technology in Education: Moving from Trivial to Significant Impact

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ABSTRACT

A plan is suggested here for moving from current trivial uses of computers in education to a future where education uses technology effectively. We have now the capability of greatly improving education. First, we need powerful visions of future systems. Then we can plan how to attain these visions. International cooperation is suggested.

THE POWER OF LEARNING TECHNOLOGY

We have in our hands today the tools which could lead us to a vastly improved educational system. We have the capability to construct a system where every student could learn to that student's full capacity, in all parts of the world, developed as well as developing countries. The key to this new learning technology is *interaction*; we can make education an active learning experience for students, replacing the passive experience of the typical class of twenty to several hundred students.

But this will not happen automatically. There is some indication that the technology will be used not to improve education, but only in the trivial ways it is mostly being used at present. Furthermore all over the world we see the likelihood of repeating errors over and over.

CURRENT SITUATION

At the present time in most countries of the world there has been far more emphasis on acquiring the hardware - computers, videodiscs, and other machinery - than there has been on the educational uses of the hardware. We have been obsessed with hardware mania. In the United States at the present time we have over 2 million computers, more than the number of teachers that we have in the public education system.

But if we investigate the usage that is actually occurring, in typical schools, it is disappointing. The computer and other related technologies occupy only a small amount of the learning time for each student, no more than a few percent in a typical school. Most learning still takes place either by lectures, or by books, at all levels of education, and in all countries.

Even the uses of educational technology we do see could often be characterized only as minor, or even trivial. Fundamentally textbooks courses may have small technology increments, occasionally even exciting material, but these increments make no fundamental difference in the learning process for most students.

Not only are our courses fundamentally pre-computer courses, but most of the teachers in the world have little idea of how to make effective use of the computer. In-service training, in the form of summer institutes, has been very disappointing in altering this

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situation. My own view is that something is fundamentally wrong about the methods of training teachers currently is use; but I will not expand further on that issue in.this paper.

The major question which I address now is, can we move from the current levels of insignificant and trivial use of the technology in education to significant use, one in which the educational system is altered for the better? It is not clear to me that the world will be wise enough to move in this direction, but it is at least a possibility worthy of serious attention. Furthermore it is a possibility that demands worldwide cooperation if it is likely to happen in an efficient way.

HOW CAN WE MAKE PROGRESS?

A two stage process seems necessary to achieve a better educational system. First we must have some idea of what we regard as desirable future systems. If we do not know where we are going, it is difficult to get there in any rational way! Surprising little attention is given to these issues. We do not see many full scale attempts to describe the future systems that could happen 20 years from today, given what we already know.

Having some view of where we are going to go, we can then develop a plan for reaching such a goal. Several plans may be possible, depending on the exact details of the future visions pursued.

VISIONS OF FUTURE SYSTEMS

Future educational systems must, at the same time, make education both more effective, and more exciting, than do current systems. The situation where only a few students learn well must be replaced by the situation where all students learn, and where all students learn to the mastery level, not only in trivial situations, but in connection with the development of higher cognitive skills. I believe that such a system is possible, using what we already know about the learning technologies.

A future system would be based on entirely different courses than we have at the present time. These courses would make extensive use of technology, so they would need to be redesigned from the beginning. Effective production strategies would need to be refined to produce such courses. The courses would provide active learning environments, and would individualize learning.

Ideally the future courses would be *hypercourses*, with a great variety of different kinds of learning materials, and with various types of links between these learning materials. Some of these links would be determined by the designers, some by student performance, some by instructor choice, and some by student choice. Thus these courses could have far more flexibility than current linear, text based, courses.

What would a future technology-based school using hypercourses look like? Several interesting examples in the literature were sketched by George Leonard. One, in 1968 was in *Education and Ecstasy*, and another was in *Esquire Magazine* in April, 1984. Readers might be interested in these richly detailed visions, based on the technology based hypercourses just suggested.

STEPS TOWARD A NEW VISION

The basis for restructuring the educational system is the production of new hypercourses, in all areas of study. In this production we must also look very carefully at questions of content. Most of our courses, in most parts of the world, are not adequate for students who will live primarily in the twenty- first century. Hence we need revision of the courses not only to improve the learning capabilities, but also to make these learning capabilities relative to the future needs of our students.

We already do have experience in producing these sizable components of curriculum with extensive use of technology. The Stanford Logic and Set Theory courses, and the Irvine Physics course, were both done many years ago, but they still furnish interesting examples of what is possible. Furthermore through groups such as the Open University in the United Kingdom, and other curriculum developments, we have learned far more about the general process of producing effective new courses, even if technology does not play a major role. But we still have much to learn about these major courses, in how to produce them, how to make them most effective for students, and in how to introduce them.

Education, I strongly believe, is still an art, not a science. We do *not* have effective theories of how students learn, and I do not believe we are close to such theories. When one examines the powerful predictive theories of physics one sees how little prediction is possible in even the most widely proclaimed contemporary learning theories.

This suggests that we need a *major experiment* in the development and use of technology-based hypercourses. We need to produce a sizable number of these courses, studying carefully various production processes, doing research in the improvement of the production processes. Effective teachers would be the key personnel in such course production. We need too to use the courses extensively with students, perhaps with hundreds of thousands or even millions of students, and conduct competent full scale formative and summative evaluations comparing them with similar courses as they exist today. Multinational testing, with all types of students, would be desirable.

The experience gained in producing a sizable group of such courses will then give us the basis for extensive restructuring of the full educational system, leading to more effective learning for all.

INTERNATIONAL COOPERATION

I suggested previously that this task might well be one that could depend on international cooperation. Experiments already show that developing courses in several languages adds only a small increment to the cost of developing in a single language. Particularly in the sciences and mathematics it is feasible to develop courses on a multinational basis, involving both the developed countries and the developing countries. Indeed as education has deteriorated recently in some developed countries the differences between the situations in these countries has become less.

There will undoubtedly be some areas, such as history, where cultural differences between countries or ethnic groups are so great that common development will not be possible. I suspect that the United States and the United Kingdom will not be able to produce learning material concerning the Revolutionary War in the United States that would be satisfactory to both countries! But in many other areas - the sciences -

mathematics - and some aspects of language learning, it will be possible to pursue joint development.

To conduct the kinds of experimental studies of extensive development and use of hypercourses suggested is practical, even in terms of current educational budgets. But we must move toward a more focused approach to spending what money we do have if this is to happen. Getting such projects started is a complex political problem. But the future of our children demands that we do move in these desirable future directions.

PLATO: Predicate Logic Advisory TOol

Toby Walsh [1]

Abstract

Intelligent Tutoring Systems often contain a domain expert to construct example solutions and a plan recogniser to model students' solution attempts; the tasks of planning in the domain expert and plan recognition in the plan recogniser are very closely related; the same heuristics that guide one can be used to guide the other. An Intelligent Tutoring System for first order predicate logic has been developed in collaboration with Texas Instruments to explore this idea. It uses a meta-level approach to represent explicitly the heuristics of the domain expert; the student modeller uses the same heuristics to guide the plan recognition; the plan it constructs is used by the domain expert to tailor the tuition to the student's solution attempt.

1 Introduction

Intelligent Tutoring Systems frequently tackle two related problems; planning by the domain expert and plan recognition by the student modeller. Both involve search within the same problem space, and both can use the same heuristics to guide that search. GUIDON2 [CB82] exploited these ideas by using the "meta-rule" representation of the domain expert, NEOMYCIN to guide the student modeller, IMAGE. NEOMYCIN contained knowledge about its problem solving (that is, its medical knowledge) and "meta-rules" about its strategies for that problem solving (that is, rules about the diagnostic process itself).The same "meta-rules" guided both the planning of the domain expert and the plan recognition of the student modeller. **PLATO** is an ITS that has been developed in collaboration with Texas Instruments to explore further these ideas [Wal87]; it is designed to teach problem solving skills for a natural deduction course in propositional and first order predicate logic. It breaks away from the production rule approach of GUIDON2 in favour of logic programming; this allows the more formal properties of a meta-level approach to be considered.

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2 Methodology

The tutoring goals adopted are derived from John Anderson's ACT* theory of cognition and his influential Lisp and Geometry Tutors [ABY85]. The aim is to provide similar instruction to that given by a private tutor, who constantly monitors and structures the problem solving, offers tuition specific to the student's needs, manages a wide range of student errors, and minimizes the cost of making mistakes. An important task of a private tutor is understanding the student's behaviour. As students step through a proof, the tutor must know what they have done, and why they have done it. To this end, the tutor solves the problem along with the students, tracing their reasoning as they enter each line of the proof.

PLATO therefore divides into 4 components :

• domain expert	a theorem prover that solves problems in a "natural" human-like way; this can be viewed as the formal definition of the problem solving skills we would like to teach the student.
• student modeller	a plan recogniser that traces students' problem solving so that help and advice can be tailored to their proof attempt.
• critic	a proof analyser that identifies redundancies in the student's and the theorem prover's proofs.
• tutoring interface	a structured problem solving environment that contains the knowledge necessary to teach and to interact with students.

3 Theorem prover

Though many theorem provers have used uniform, domain independent resolution type techniques, there has been a considerable switch away to natural deduction theorem provers which use domain dependent knowledge to guide their search. One such system is PRESS [BW81] which very successfully solved algebraic equations using a technique called *meta-level reasoning* to guide the search. This technique is the main source of inspiration in the design of the theorem prover.

In **PLATO** inference is conducted at two levels simultaneously: at the meta-level and, as a side effect of the inference at the meta-level, at the object-level. The object-level holds knowledge about the domain and the problem (in particular, the inference rules of first order predicate logic), whilst the meta-level contains control or strategic knowledge (in particular, methods of constructing a proof). At the heart of all this is *knowledge*, not only of inference rules but also of problem solving methods, that is, meta-level knowledge [2].

4 Student modeller

The student modeller is a plan recoginser that traces the student's problem solving. In many ways, plan recognition is the inverse of planning. Planners and plan recognisers are often closely linked (see for example [CB82] for the links between Image & Neomycin, or [Gen82] for Advisor & Muser); both planners and plan recognisers tackle very similar problems : combinatorial explosion in the search space of possible plans, existence of multiple solutions, and plan representation. A meta-level approach allows the same heuristics that guide the planner through an explosively large search space to be used to direct the plan recogniser. This is only possible because this meta-knowledge is explicitly represented. The purpose of the student modeller is to construct a plan of the student's proof attempt; this plan is used by the theorem prover to advise the student what they should do next.

5 Critic

One vital aspect of a private tutor's job is that of criticism. **PLATO** therefore has a third component, a critic. This critiques students' proof attempts, spotting redundant lines in their proofs; the theorem prover uses the same critic to remove redundant lines from its own proofs. The critic could also look at less clearly defined issues like linearity, style, and directness of proof.

6 Interface

The tutorial interface is designed to provide a structured environment which is easy to use, and to learn to use. By providing such an environment, the low level burden of writing down proofs can be reduced, allowing the student to get on with learning the important problem solving skills[3]. To this end, extensive use is made of WIMPS: windows, icons, mice and pop up menus. The interface runs under Paneltools, a windowing extension to Quintus Prolog 2.0 developed at the Turing Institute in Glasgow.

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[2] meta-level knowledge contains all knowledge about knowledge, though focus here is merely on the control knowledge aspects of meta-level knowledge.

[3] that is not to say that these low level skills are unimportant, but that the aim of **PLATO** is to teach problem solving skills and not the inference rules

7 Conclusions

Because of the close parallels between planning and plan recognition, a meta-level approach to the design of Intelligent Tutoring Systems seems very appropriate. The domain expert and student modeller can share the same meta-level knowledge to guide their search for example solutions and student plans. This technique has been successfully explored in the design of an ITS for first order predicate logic.

Acknowledgements

This research was supported by a SERC studentship. I would like to thank my two supervisors, Don Sannella and Paul Brna; Fausto Giunchiglia for his infernal and invaluable questioning; Ray and Babs for making it possible in many ways; Ru for being Ru; and all my friends in London, Edinburgh, Cambridge and Washington who make it all worthwhile.

References

[ABY85] J. Anderson, C.F. Boyle, and G. Yost. The geometry tutor. In *Proceedings of IJCAI-85*, pages 1–7, International Joint Conference on Artificial Intelligence, 1985.

[BW81] A. Bundy and B. Welham. Using meta-level inference for selective application of multiple rewrite rule sets in algebraic manipulation. *Artificial Intelligence*, 16:189–212, 1981.

[CB82] W.J. Clancey and B.London. *Plan recognition strategies in student modelling : prediction and diagnosis.* Technical Report STAN-CS-82-909, Stanford University, 1982.

[Gen82] M.R. Genesereth. The role of plans in intelligent tutoring systems. In D. Sleeman and J.S.Brown editors, *Intelligent Tutoring Systems*, Academic Press, 1982.

[Wal87] Toby Walsh. *PLATO: Predicate Logic Advisory TOol.* Master's thesis, Dept. of Artificial Intelligence, Edinburgh, 1987.

AN ITS FOR THE FORMAL SPECIFICATION LANGUAGE Z

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ABSTRACT

This paper describes the design and pilot implementation of a tutoring system for Z - a mathematical notation used in the specification of software systems. Z is based on a combination of set theory, predicate logic and some additional Z specific notation and syntax. It is a concise, precise and abstract notation that describes the function and operation of a software system. Widespread use of Z would necessitate extensive retraining of existing professionals. As the project has progressed and implementation attempted the original design of the ITS has changed. It is argued that the 'technical' nature of the subject, the relative sophistication of the learner population and the restricted learning goals being attempted mean that this ITS can be a simpler system than first envisaged. Finally, the paper argues that these factors need to be given much more consideration when design principles for IT's are proposed.

INTRODUCTION

The two major approaches to the application of computing technology in education have been the 'discovery learning' or 'microworlds' approach (ref 1) and the 'expert tutor' approach (ref 2). The objective of this latter approach has been for the system to simulate the knowledge, skills, and activities of a good human teacher to produce an Intelligent Tutoring System (ref 3). These two alternative approaches have, by and large, proceeded along seperate lines of development. Recently, however, there have been attempts to examine how their differing philosophies and approaches to learning can be incorporated within a single conceptual framework (refs 4, 5). This paper will explore the ITS approach to computer based learning by first providing a short review of current proposals. Second, a description of an outline proposal for an ITS for Z will be presented together with an outline of how, as the partial implementation, of the system has developed the original design has been modified. Finally, some general conclusions will be drawn on the basis of this research which have implications for the development of ITS methodology.

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REVIEW

The fundamental assumption underlying intelligent computer tutoring is that the system ought to continuously provide instruction that will be beneficial for the student. This implies that the system has to know the student's current state of knowledge; knowledge of the domain of instruction to decide what the student's progress ought to be and also knowledge of instructional strategies to decide what to present to the student. In Ohlsson's terms (ref 6) "the computer can, ..., be programmed to adapt both the content and form of instruction to the student's understanding of the subject matter." This perspective led initially to highly modular designs in ITS's and a number of architectures were proposed with different internal structures, e.g. O'Shea's five ring model and Anderson's ACT model (see refs 7 and 8 for reviews). The variety of these proposals which all have a strong resemblance to each other reflect differences in underlying philosophy of instruction. For example, the five ring model has no explicit domain knowledge, this being embodied within the various teaching modules, whilst the ACT system has explicit domain knowledge but no explicit model of the student's knowledge, preferring instead a knowledge of possible errors that the student can make which can be diagnosed and remediated. These ITS models represent only two of the alternatives that have been proposed but their diversity illustrates the problem in finding a set of general principles to guide the design of ITS's (ref 6). One method of pursuing this goal is to design and implement systems and derive principles from their historical evolution. the remainder of the paper will describe our experience in this endeavour.

AN ITS FOR Z

The topic domain we selected as the content area of our ITS is the formal specification language Z (ref 9). Formal specification languages are becoming an increasingly important tool in software engineering. These languages allow computer systems to be represented in an abstract and formal manner and indicate what functions systems perform with little concern as to how they should be implemented. Z is based on typed set theory and predicate logic with some additional Z specific notation. A Z description sits between a customer's natural language requirement and the programmer's final code. The software industry believes that the widespread use of such languages will produce a more rigorous development cycle with resultant benefits.

Our initial ITS structure consisted of five interlinked components:

(1) teacher module - the system executive that co-ordinates the activities of the other modules;

(2) interface module - controls dialogue between student and system;

(3) teaching strategy module - decides on the instruction to be applied at different points in time;

(4) domain expertise module - the knowledge of Z being imparted to the student; and

(5) student module - a record of the student's knowledge and progress, incorporating both accurate knowledge and misconceptions.
the student; and

To attack the problem of system implementation two prerequisites were identified. First, we had to identify what particular problems and difficulties students might have in learning Z and produce an outline curriculum. Second, it was also necessary to consider the representation of the domain knowledge since this would form part of the domain expertise the domain expertise module and the student model. To these ends we studied learners in industry being introduced to Z via a three-day text based course and also in-depth studies of individual students learning Z using the same course material but on a guided self-study basis. Second, a set of parsing procedures, written in PROLOG, was produced, which analyse the syntactic correctness and consistency of Z equations. Using this rule-based representation it was envisaged that the domain expertise module would consist of a fixed collection of these rules. Whereas the student module although also consisting of a subset of these rules would have in addition deviations from the rules which would represent the student's misconceptions identified from their input. The findings from each of these aspects will be considered in turn and their implications for ITS design drawn out.

In working through example exercises students may encounter difficulties, make errors and labour under misconceptions. The problems they face range from the straightforward; learning a new notation, to the subtle; achieving an appropriate level of abstraction in their final solutions. An ITS should ideally help with all of these problems, but this diversity highlights the question of a starting point. Students may well have some prior mathematical experience eg. of set theory and perhaps logic. What knowledge should be assumed or built into the student model? This is particularly problematic for the subject population for whom this ITS was envisaged, ie. existing professionals, who may have quite different backgrounds and degrees of fundamental mathematical knowledge and expertise. Contrast this situation with say tutoring young children on arithmetic skills where by and large the assumption of an 'empty' initial student model might well be reasonably accurate.

Our studies show that there are at least three different types of competence deployed by a skilled Z user.
(i) understanding the basic mathematical notation;
(ii) ability to create an extended mathemtical expression which captures some aspect of a specification.
(iii) ability to choose an appropriate form of abstract representation for a specification.

These categories show an increasing emphasis upon the abstract, a larger 'grain' of problem and a decreasing attention to detail. Our present ITS design is restricted to teaching the first two types of competence and of these, concentrating upon the second. There are several reasons for this including: the greater need within the industry for the skill of reading as opposed to writing Z; the difficulty, even for human tutors in commenting fruitfully upon abstract design; and the prior knowledge of all or part of the basic mathetmatics which many of the potential students will have. Thus we restricted the set of learning potential students will have. Thus we restricted the set of learning goals that the ITS and the student have to meet. For the student the overall task of writing a complete Z schema is broken down into sub tasks of writing single lines of the schema in response to the system's functional description of that line. The checking as to whether this sub-goal has been achieved can be dealt with in mainly syntactic terms.

From these exercises the student module is constructed from two types of item:- rules representing methods of constructing Z expressions that the student has demonstrated he can deploy competently and rules representing misconceptions manifested by the student. The module does not need to contain a detailed map of the student's basic mathematical knowledge. If the student shows many deficiencies in basic knowledge the system can conclude that not much benefit will be gained at this level of teaching and advise accordingly, Because of the learner population and the restricted goals of the ITS this rather simple student module looks likely to be adequate.

CONCLUSIONS

Our initial goal was to design and implement an ITS to teach Z. As we have shown, to make this viable a number of constraints and assumptions had to be introduced, which in turn meant simplifying components of the ITS structure. At present such simplifications are done for each ITS application, resulting in the range of architectures outlined in the Introduction. The production of principles of ITS design will depend on a systematic classification of what assumptions should result in a particular ITS design. These design decisions are exactly what good human tutors do. They meet the range and complexity of educational situations by adaptively adjusting their behaviour to the knowledge base, the student and the skills to be acquired. In some sense then the principles of ITS design are akin to the principles of good human tutoring.

REFERENCES

1. S Papert, Mindstorms (Basic Books, NY, 1980).
2. J S Brown and R R Burton, Cog Sci, 2, 155-192 (1978).
3. D Sleeman and J S Brown, Intelligent Tutoring systems (Academic Press, London, 1982).
4. J Self, J Comp Ass Learn, 1, 159-166 (1985).
5. R W Lawler and M Yazdani, Artificial Intelligence and Education (Ablex, N J 1987).
6. S Ohlsson in R W Lawler and M Yazdani, Artificial Intelligence and Education (Ablex, N J, 1987).
7. M Yazdani, Artif Intell Review, 1, 43-52 (1986)
8. C Dede, Int J Man-Mach Stud, 24, 329-353 (1986)
9. I Hayes, Specification Case Studies (Prentice-Hall, NJ 1986)

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REPRESENTATIONS OF TASK AND PROGRAMMING KNOWLEDGE IN INTELLIGENT TUTORING SYSTEMS FOR PROGRAMMING

C.K. Looi

ABSTRACT

This paper presents a brief review of the different representations of task and programming knowledge used in currently existing Intelligent Tutoring Systems (ITSs), program debugging and program construction tools, and discusses how they might be applicable in the construction of a Prolog ITS.

INTRODUCTION

Intelligent Tutoring Systems (ITSs) for teaching programming languages need to be able to reason with programming knowledge in order to able to analyse students' programs, detect the bugs in them, suggest corrections, and explain the bugs and their likely causes to students. One key component of these ITSs is the representation of knowledge about programming and programming solutions. We review some of the different representations of programming knowledge used in currently existing ITSs, program debugging and program construction tools, and discuss how they might be applicable for Prolog and we motivate an algorithm-based approach for debugging Prolog programs in Prolog ITS.

Studying representations of programming knowledge also allows us to explore epistemological issues concerning the nature of knowledge that is used for programming and how that knowledge can be learned and thus how it can be effectively taught. The long-term pedadogical objective of research into ITSs for programming may be to improve the quality of computer programming education. For instance, Soloway and his co-researchers have provided empirical evidence that Pascal programmers use a lot of plans in programming activities (ref 1), and have argued for more explicit teaching of programming plans as a basis for a programming curriculum instead of the traditional emphasis on the syntax and the semantics of the language.

PROLOG PROGRAMMING TECHNIQUES

By programming techniques in Prolog, we mean the use of common implementation methods specific to the Prolog language which can be brought to bear on a wide range of problems. Generic techniques concerned with simple list processing include :

- smashing a structure recursively to find a desired part, or until some part satisfies a required test (for example, member/2)
- smashing a structure recursively while building another from selected parts of the first or from information about the first
- using backtracking generatively, for generate-and-test
- using auxiliary arguments for communicating data or 'results'
- incrementally instantiating the parts of a desired structure

While programming techniques have an important role to play in an ITS for Prolog especially in the tutorial component since program techniques are what we want to teach, a technique-based approach is itself not sufficient for bug diagnosis. The automatic detection of the use of techniques in a student's program is a difficult task because the student may have used a technique incorrectly or used an inappropriate technique. An automated debugger needs some expectation of what the student is intending to do. Consider these programs :

PROGRAM 1 :

```
append([], L, L).
append([A|X], Y, [A|Z]) :-
    append(X, Y, Z).
```

PROGRAM 2 :

```
reverse([], L, L).
reverse([A|X], L, Y]) :-
    reverse(X, L, [A|Y]).
```

Both these programs use the first argument as the iterative counter - a plan of using a list to control the recursion. Used in the usual mode sense append(+, +, –), which means that in any invocation of append the first two arguments are to be instantiated and the third uninstantiated, Program 1 builds up the output structure in the third argument of the head goal. This technique builds the intended result in the head goal. Used with mode reverse(+, –, +), Program 2 builds the intended structure in the third argument of the recursive goal. This suggests that mode information as well as other intentions of the programmer must be brought to bear for debugging. If techniques are identified without knowledge about intentions, then buggy and correct code cannot always be distinguished. Thus, if the student's code is :

```
foo([], L, L).
foo([A|X], Y, Z) :-
    foo(X, Y, [A|Z]).
```

without reasoning with intentions and task-specific information, an automated debugger is not able to distinguish whether the program is correct code for reverse/3 or buggy code for append/3 or whether the programmer has intended to build the result structure in the head goal but realised it incorrectly, or has correctly used a plan to build the result structure in the recursive subgoal.

PROGRAMMING PLANS

The concept of programming techniques is different from the concept of plans as used in the work of Soloway and his co-researchers at Yale. They consider programming goals and plans as the two key components in representing problems and programming solutions. Programming plans describe stereotypic action sequences in programs and are intended to be language independent. The notion of plans in Yale has been derived from empirical observations that programmers use programming plans in understanding and writing programs. The claim is that programmers write programs by determining what goals and constraints must be satisfied, and then selecting plans which satisfy these goals and constraints.

PROUST is a computer program developed at Yale that analyses Pascal programs written by novice programmers, detects the bugs, and explains them and their causes to the programmers. It embodies the view that programmers use plans to map their intended goals into code. PROUST's task is thus an attempt to invert this mapping, mapping the code back into the programmer's goals. The mapping process involves selecting plans which maps goals to code. The representation of a plan in PROUST is a frame with a set of slots. The main part of the plan is the template which is fairly close to the Pascal code they are matched against. This is PROUST's representation of the plan for a WHILE loop in Pascal (ref 2) :

```
Constants :   ?Stop
Variables :   ?New
Template :
    InitInput :    subgoal Input(?New)
    MainLoop :     while ?New <> ?Stop do
                        begin
    Process :               ?*
    Next :                  subgoal Input(?New)
                        end
```

While we believe that Prolog programmers also use a lot of plans in their programming activities, the notion and representation of plans in Prolog are subjects for further study. A template-like representation of plans as in PROUST is suitable only for imperative sequential languages like Pascal where there are keywords to anchor the analysis. In Prolog where the model of computation is based on unification, a template-matching process falls short.

CLICHES

One of the key representations of programming knowledge used in the Programmer's Apprentice (PA) project at MIT is the cliche. The PA is intended to assist in the easy parts of the programming process like spelling out the full algorithm which the programmer has specified in the form of a plan. The Knowledge-Based Editor in Emacs (KBEmacs) which emerges out of the PA project focuses only on the task of program construction. KBEmacs is a program editor that allows a programmer to specify the algorithm structure of a program rather than its textual or syntactic structure.

A cliche is defined as a standard method for doing a task, a high-level template that represents the dataflow and control flow of an algorithm where the place-holders are the "roles" of the task. Roles vary from one use of the cliche to the next but have well-defined purposes. Here is an example of a straightforward cliche called average which computes the average of two input numbers taken from (ref 3) :

```
(DEFINE-CLICHE AVERAGE
        (PRIMARY-ROLES (X Y)
          DESCRIBED-ROLES (X Y)
          COMMENT "computes the average of {the x} and {the y}")
     (// (+ {the input x} {the input y}) 2.0))
```

The concept of cliches is similar to the concept of programming plans as used by Soloway. One difference is that Soloway's plans are organised round the goals they implement. Cliches provide a vocabulary of relevant intermediate and high-level concepts for the programmer to interact with the PA. It facilitates program construction by allowing the programmer to specify his program in terms of cliches chosen from a library of prestored cliches.

The idea of using cliches for program construction is intended to be language independent although cliches themselves are not language independent. To support a new language, a different library of cliches which are appropriate for writing programs in that language has to be provided. The dataflow and control flow of the cliche is intended to be nonvarying, with all the variability confined to what fills the roles. The number of roles and the way they interact are fixed in a cliche, analogous to the situation in many programming languages in which the number of arguments to a subroutine call is fixed. Unfortunately, there are algorithms which do not have a fixed number of roles. For example, it is easy to define the cliche which computes the average of two numbers or a different cliche which computes the average of three numbers. However, it is not possible to define the cliche which is the generalisation of these two cliches.

The concept of using cliches as a tool for program construction is practical but the use of a cliche library to recognise cliches from constructed programs falls short. While it is relatively easy to convert cliches to code, the inverted process is a many-to-one mapping which is a difficult one. In this aspect, the PROUST system is reasonably successful in recovering the inverted mapping through a sophisticated process of heuristic code-matching, as demonstrated for a few programming problems.

PRODUCTION RULES

The representation of programming knowledge as production rules has been used in Anderson's GREATERP tutor for beginning LISP programming (ref 4, 5). The tutor is based on the ACT* theory of cognition which makes claims about the organisation and acquisition of complex cognitive skills such as those required for computer programming. ACT* and its successor architecture PUPS make an important distinction between declarative and procedural knowledge. Declarative knowledge is what gets stored in human memory when someone is told something, as in instruction or reading a text. Procedural knowledge is what can only be acquired through the use of the declarative knowledge through practice, and embodies knowledge in a highly efficient and ready-to-use way. The ACT* theory claims that procedural knowledge is created from the use of declarative knowledge in problem-solving.

In the PUPS architecture, declarative knowledge is represented in schema-like structures. These structures are thought to be what are acquired by the student before they are later compiled into procedural knowledge. Procedural knowledge is represented by a set of production rules that define the skills necessary for programming. The aim of the tutor is to create experiences that will cause students to acquire such production rules. Here is an example of production rule :

IF the goal is to code a function on a list structure, and
that function must inspect every atom of the list structure, and
the list structure is arbitrarily complex
THEN try *CAR-CDR* recursion and set as subgoals
1. to figure out the recursive relation for *CAR-CDR* recursion
2. to figure out the terminating cases when the argument is nil or an atom.

Starting off from some programming goal, appropriate production rules are applied to decompose the goal into subgoals until goals are reached which can be accomplished by direct translation into code. GREATERP attempts to model the student's programming knowledge in terms of a set of correct and incorrect or buggy production rules he is thought to use when programming. The buggy rules are derived from observing the errors students make when they use the tutor, trying to understand the origin of the errors and coding the inferred buggy productions into the system. Thus the programming knowledge of the student is modelled in terms of a set of executable rules.

To use production rules as a model of the knowledge used for programming, we need to at least rely on work on the representation of Prolog programming techniques or plans as techniques and plans are what the action parts of the rules are to implement. For example, we can code an equivalent rule for Prolog similar to the production rule above.

ALGORITHMS

Our approach to Prolog code analysis is to view the task as uncovering the mapping from algorithm to its decomposition into Prolog code. The approach synthesises programs in the space of possible programs by first selecting an algorithm and then decomposing the algorithm into a procedure that invokes subtasks, subtasks into further subprocedures and eventually into code. This approach can be seen in the light of our view of the learning phrases a Prolog novice goes through. In the first few weeks of Prolog, a student has to cope with learning about the new syntax and semantics of the new programming language. His main preoccupation would be the implementation of common algorithms into Prolog code. Indeed, most Prolog texts concentrate on the ways of converting some algorithm into known Prolog formalism (ref 6, 7). After the first few weeks of cognitive disorientation with a new language, the main preoccupation shifts to the task of turning some problem statement into an algorithm. Our intention is that Prolog ITS will be used in the initial learning phrase of the Prolog novice to lead students through fairly standard exercises of list and number manipulation. Our approach is also suitable for debugging bugs at the different levels of abstraction. We also relate our approach to the use of Prolog programming techniques. For tasks and subtasks are mapped to code by selecting and using appropriate programming techniques. The wrong use of a technique or the use of an inappropriate technique will result in a mapping of subtasks to incorrect procedures or code.

Our view concurs with the empirical observations of Someren (ref 8). Someren describes two approaches to programming in Prolog : "logic programming" in which a program is written as a theory, formulated in logic, and designing the program involves defining relations and properties; "algorithmic programming" in which a program is written as an implementation of some algorithm, like programming in some instruction-oriented language. Someren observes that the first method of Prolog programming is not common among novices. Our approach allows us to identify bugs in behavioural terms at these different steps of the algorithmic process :

1. Design of the algorithm
2. Translation of the algorithm into Prolog
3. Verification of the program by executing it (mentally or on a machine) on some examples.

CONCLUSION

We have presented a brief review of the different representations of programming knowledge used in existing ITSs and have proposed some ideas on what representations might be used for a Prolog ITS. We have incorporated these ideas in a program called APROPOS (ref 9) which is part of the expertise module of a Prolog ITS but the discussion and evaluation of APROPOS are beyond the scope of this paper.

REFERENCES

1. E Soloway & K Ehrlich, *Empirical Investigations of Programming Knowledge*, IEEE Transactions of Software Engineering SE-10, 5 (1984)
2. W L Johnson, *Intention-Based Diagnosis of Errors in Novice Programs*, PhD Thesis, Yale University (1985)
3. R C Waters, *KBEmacs : A Step Toward the Programmer's Apprentice*, MIT AI Laboratory Technical Report 753 (1985)
4. B Reiser, J R Anderson & R G Farrell, *Dynamic Student Modelling in an Intelligent Tutor got Lisp*, in Proceedings of the International Joint Conference on AI (1985)
5. J R Anderson, C F Boyle, A Corbett, & M Lewis, *Cognitive Modelling and Intelligent Tutoring*, Advanced Computer Tutoring Project, Carnegie-Mellon University (1987)
6. L Sterling, & E Shapiro, *The Art of Prolog, Advanced Programming Techniques*, The MIT Press (1986)
7. I Bratko, *Prolog Programming for Artificial Intelligence*, Addison-Wesley (1986)
8. M W van Someren, *Misconceptions of Beginning Prolog Programmers*, Memorandum 30, Department of Experimental Pyschology, University of Amsterdam (1984)
9. C K Looi, *Automated Program Analysis in a Prolog ITS*, Department of AI, University of Edinburgh (1988)

DEVELOPING "TEACHER TECHNOLOGISTS": EIGHT U.S. CASE STUDIES

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ABSTRACT

Eight American case studies were conducted during the summer of 1987. Using a perception based model, three goals were investigated: a) identification of alternative approaches for teacher training in technology; b) analysis of training purposes and effectiveness; c) development of policy options. Training emerged as most important where technologies were clearly seen as a tool which could be integrated into the curriculum. Toward this end, the most successful efforts all addressed the goal of developing a "critical mass" of staff usage early on. Ironically , where the goal is **not** to produce "teacher technologists" but rather to train "excellent teachers who use technologies fully", the number of teachers effectively and enthusiastically using technologies was the greatest. Successful strategies included: spearheading training with effective administrative change agents, supporting long term internal funding, attending to "psychic rewards", direct principal involvement, basic applications training followed by informal networking and easy access to technologies both at school and at home.

INTRODUCTION

This study had three goals:

- identify possible alternative approaches for teacher preparation, training and support in the use of technology;
- analyze the different purposes and relative effectiveness of the training alternatives;
- develop policy options that might be implemented to strengthen teacher training support in the use of technology.

THE METHOD

The authors used a perception-based model of case study design to investigate developmental sequences of teacher training in technologies. Funded by the Office of Technology Assessment (US Congress) and conducted during the summer of 1987, the intent was to identify emergent patterns across a diverse sample of teacher participants and trainers. Toward this end, nine major questions were seen as critical:

1. **What is the purpose(s) of training?**
2. **What training has occurred to date?**
3. **Who are the participants in the training?**
4. **Who are the trainers?**
5. **What resources have been allocated for technologies training?**
6. **What has changed over time in the training?**(eg, purposes, actors, resources)
7. **What have been the consequences of technologies training thus far?**
8. **What facilitated and what hindered training and the use of technologies?**
9. **What policy issues have been emerging?** (equity, training, funding, replicability, historical patterns, successful and deterring factors, impacts on instruction)

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Special efforts were made to meet directors of research and evaluation to gather supportive documentation as well as interview top-level administrators (eg, superintendents and associate superintendents) to understand the significance of their involvement over time.

Indepth interviews provided insights about both successes and obstacles and potential replication. In order to get a comprehensive picture, we studied training conducted a variety of levels: **building level** (Hennegan Elementary School in Boston, MA); **district level** (Albuquerque Public Schools, Jefferson County School District, Alabama, and Houston Independent School District); **university level** (University of New Mexico in Albuquerque, NM and Leslie College in Boston, MA and University of Minnesota in Minneapolis, MN); **state level** (Minnesota State Department of Education); and **consortial/regional/national level** (IBM's National Computer Training Institute and Association for Supervision and Curriculum Development's Elementary School Consortium, and Minnesota Educational Computing Corporation). Although the sites chosen represent an a wide variety of training programs, they were not necessarily the best, the most interesting, or even typical of the training programs offered throughout the United States. They did provide us, however, with significant insights into the training needs in the area of technology and education.

RESULTS

Purposes of Training:

Training emerged as most important where technologies were clearly seen as a **tool which could be integrated into the curriculum**. Toward this end, the most successful efforts all addressed the goal of developing a "critical mass" of staff usage early on. Ironically , where the goal is **not** to produce "teacher technologists" but rather to train "excellent teachers who use technologies fully", the number of teachers effectively and enthusiastically using technologies was the greatest.

Where manipulation of specific software programs or applications were the primary objectives, training a critical mass of teachers was less important, and the training did not need to have the breadth as in the programs that went for integration.

Importance of Key Change Agents for Development of Cadre:

One of the key findings of this case study is the necessary presence of change facilitators, a catalyst(s), who can mobilize interest in technologies beyond hardware and software issues-- to an action level so that training is systematically designed and budgetted. Change agent styles were varied and ranged from "low-keyed" to charismatic individuals to one system having its "cabal of three". In the absence of these key change facilitator, it appeared technology training issues failed to surface and capture the attention of decision makers.

Necessary Resources:

Successful change agents did not operate in isolation. Training seemed to require a holistic effort. One key actor across all successful efforts sites was the presence of a private vendor, particularly Apple Computers, Inc. and IBM.

Other key actors included local and state politicians, economic development groups, and State Departments of Education. The consistency and long-term nature of this support cannot be overemphasized. The analogy of the tortoise and the hare comes to mind when looking at the steady efforts of Minnesota marshalling its scarce resources versus rapid efforts in Texas which could not be sustained when the oil industry declined.

The role of parents as key players was not consistently displayed across sites.

The Level and Kind of Resources Available:

The eight case studies revealed **a wide range of monetary resources**. Successful training endeavors cost as little as $10 per teacher to over $1000 each.

Effective staff development efforts looked at the funding issue beyond short-term hardware and software purchases and "quick-fix" training for an elite core. Consistent across all sites, ready access to equipment was one of the most frequent issues that impacted the long-term success of training and transfer value to the field. When the majority of hardware and software resources were gifts, the question of permanent, internal support was only postponed.

The present research suggests that money alone is not a sufficient factor for predicting success in training a "cadre of technologically literate teachers". **Psychic rewards were seen to be critical**. The enthusiasm and excitement in Jefferson County, Alabama; the great pride in Blue Earth and other Minnesota communities; the enjoyment of associating with the famous and having important visitors at Hennigan School; national recognition that comes from being the center of attention and highly visible as in Houston; the community support that passes a five million dollars bond levy earmarked just for technology as in Albuquerque--all played an essential role in explaining why people can be trained in the absence of individual cash incentives.

Finally, another essential factor was building level support, particularly direct involvement by principals. The significance of superintendents seemed to be less critical and particularly during the onset of training, their role was often avoided or postponed by training developers.

The Trainers and their Styles:

One conclusion stands out: **the most effective teachers were those who are seen as teachers, not technologists** or members of the "technologist priesthood." Usually these teachers were reported to have recent classroom experience, successfully used technologies in *their* teaching, knew how to integrate technologies into their subject areas, were enthusiastic and able to work with adults in groups and individually, and were sensitive to the fears of non-users and did not try to train teachers to be programmers. The majority of trainees also commented that the most effective trainers encouraged hands-on, practical, interdependent and independent learning. Interviews with trainers consistently reported their formal training and degrees appeared to be totally irrelevant to their success.

Where aides or specialists handled training and teaching, the long-term instructional effects on regular teachers tended to be more transitory. The most effective training seemed to occur when there was an organized and formal training program followed by continuous informal training at the building level and easy access to technology hardware and software. When this **three-step sequence** was the case, teachers did not seem to harbour resistance to the initial training if it was "mandated".

The size of districts seemed to have an impact on the type of trainers that emerged. The size of the training task led large districts to train their own staff. Small and medium-sized districts turned to external training programs such as Lesley College or state or regional service centers like MECC and TIES in Minnesota.

Factors Encouraging Training:

The list is simple, not unique to training in the area of technology, and really not surprising:

- Support from a principal
- Availability of resources and where resources are limited, teachers should have a choice in which they want first if they can not have everything at once.
- Supportive, practical training from a permanent, broadly representative support team or teams that include central decision-makers as well as teachers. Ultimately, the Superintendent and Board must be informed and supportive, and must make their support known to teachers.
- Mechanisms for easy availability of coaches and which encourages teamwork and networking (formal and informal)
- A clear view of how teachers can use technology to teach specific subject matter (or to integrate specialities into a broader view of the curriculum)
- Flexibility, risk-taking, experimenting with opportunities in the classroom, and a principal who will be a buffer to opposition from resistive building staff and administrators

The point is that getting teachers fully involved in using technologies does not require them to become technicians, or specialists in technologies. Rather the objective is to train them to use the technologies as tools in their teaching. They need to know how to use equipment and software. But these objectives are not *ends*. They are steps in a much more important process: the use of this knowledge, these skills in improved teaching of the curriculum. No single teacher needs to "know it all", to be a technologist, to be a specialist. Team work and sharing make the use of diverse technologies possible.

Factors Inhibiting Training:

Surprisingly, time, or the lack of it, was not a negative factor. In fact we were told over and over that we should talk to the busiest teachers; "they are the ones who have time for growth." Rather the strongest impediments were reported to be:

- A technical (or programming) and/or narrow approach to technologies' utility;
- Opposition from the principal and system at large, particularly in terms of mastery based instruction which prohibits alternative methods of meeting common ends;
- Limited access to hardware and software at school and home; equity issues within systems
- The absence of rewards, either psychic or monetary.
- Emphasis on theory and trainers who were seen as technical specialists without experience in using technologies in *their own* classrooms to train teachers was also a significant impediment. **In this regard, higher education institutions seemed particularly remiss.**

FINAL COMMENTS

This study began by focusing on the alternative approaches that are available to create a cadre of "teacher technologists". The authors of this study now believe that was the wrong focus, the wrong objective. Rather we suggest that the question should be **how do we create a cadre of teachers who are able and willing to maximize the use of technologies as powerful tools to improve and reshape their teaching?** We conclude that federal, state, and local policies should **not** be directed to the training of a select group of teacher technologists. ***We believe training in the use of technologies as tools must be provided to all teachers.***

I.T. IN SCHOOLS - PLANNING COURSES FOR ADVISORY TEACHERS

Maurice Hart

ABSTRACT

If teachers are to act in an advisory capacity in schools then they need courses to equip them technically and professionally in specific ways. An analysis of these requirements and present patterns of course provision leads to suggestions for structures for future courses.

INTRODUCTION

It is now being recognised that every school should have at least one teacher who can act as a catalyst for introducing the use of Information Technology (I.T.) across the curriculum. These advisory teachers need courses to equip them with the necessary range of knowledge and skills. This paper discusses details of the requirements of such teachers. These requirements are considerable and can only be covered by an extensive period of study. The paper therefore outlines possible structures for award bearing part-time courses that are equivalent to one year full-time courses. The paper arises from the experience of planning two in-service courses for teachers, and being involved in the validation of many others.

THE REQUIREMENTS OF ADVISORY TEACHERS

If teachers are to act in an advisory capacity in their schools then they need knowledge and skills which come under four related headings.

- Technical expertise
- Knowledge of possibilities in the classroom
- Difficulties surrounding curriculum development
- Staff and resource management

Because the growth of the use of I.T. in education is so new only a tiny proportion of teachers have used I.T. in their own school and college careers. In order to deal with this lack of basic knowledge early in-service work tended to concentrate on giving teachers structured courses that placed the emphasis on technical details and, in longer courses, on an academic study of applications. Many teachers have been on short in-service courses, and some enthusiastic teachers have also undertaken personal study in order to make themselves "experts". This expertise usually only applies to one particular system and such teachers often have a very narrow view of the nature of I.T. It is also a common experience in schools that expert colleagues keen to show off their skills can act as a turn-off for other teachers. Courses

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for advisory teachers should contain a component that increases technical expertise, but this needs to encompass an increase in breadth of knowledge across a range of principles, systems and applications, as well as an in-depth knowledge of systems currently popular in schools. If possible this work also needs to be undertaken in contexts that help the teachersto explore methods of approach that will carry across to their own work in schools.

The possibilities relating to the use of I.T. in classrooms are growing very rapidly. Already it is becoming apparent that the use of I.T. is changing our perceptions of the writing and publishing activities of children. Radical changes are also likely in the other "basics" of mathematics and science, as well as in art, music, and technology. In the U.K., for many children up to the age of eleven, the use of the technology in many capacities is already a part of their day-to-day environment in the same way as books, apparatus, TV etc. For most older children the use of I.T. is still special; they tend to go and use the technology in a different environment rather than having it as a part of their ordinary classroom activities. Advisory teachers need to be aware of the current and future possibilities across the whole band of subjects and age ranges. They also need to understand the capacity of the use of I.T. to act as a change agent in classroom activities and processes.

There can be no doubt that for an up-to-date education the use of I.T. should permeate the classroom experiences of all children. Such a change involves a major process of curriculum development. Teachers working in their own school environment probably have the best chance of overcoming the built in inertia that is the major obstacle to real curriculum development. It is vital that such teachers also know, and can apply, the parameters relating to any kind of curriculum development. These include an analysis of methods and processes, plus a knowledge of present initiatives and proposals. All teachers have their own set of priorities and interests in this field. An advisory teacher must be able to take account of these and relate to them for individual teachers.

Some details of the staff management problems which advisory teachers face have already been highlighted: a careful use of expertise, awareness of the ways that I.T. can act as a change agent in the classroom, knowledge of other teachers' priorities and interests. These need to be related to general school management issues, and to the management of resources. Generally speaking activities like special one or two day courses have done little to benefit the introduction of I.T. into the curriculum. These advisory teachers need to discuss ways of progressing, test them in their own establishments, and revise them in feedback sessions on the course in order to find effective ways of proceeding.

PRESENT COURSE STRUCTURES

Many award bearing in-service courses are already in existence which aim to provide teachers with expertise in all or most of the areas given. Within this relatively common framework there are, however, fundamental differences in emphasis and in methods of approach. These can best be illustrated by considering a spectrum with extreme opposites at either end as follows.

"Spectrum of differences"

High technical content	High professional content
Concurrent teaching units	Consecutive units
Assessment by examination only	Assignments only
Teachers from FE/ secondary only	Includes primary teachers

Courses at the left hand end often generate exemption from the British Computer Society Part 1 examinations. The concurrent teaching can involve as many as five different teaching slots in a "day" lasting from 1.30 p.m. to 9.00 p.m. Earlier courses were largely driven by the lack of qualified Computer Studies teachers and tended towards the left hand end of the spectrum. There has been a move towards the right hand end as the inter-relationship between computers and the school curriculum has developed. It has also become apparent that there needs to be a flexibility in these courses which is difficult for single institutions to provide. If such courses are to emphasise processes for change, and how they are to be achieved, this aspect needs to be closely related to individual subject and school circumstances. A rigidly timetabled pattern of elements in one building will not meet these requirements. The teachers will need to work collaboratively with outside agencies and other teachers in many different working environments.

POSSIBLE FUTURE STRUCTURES

Many courses are now moving towards a mixed collection of elements, with some long units of 60/70 hours, that occupy whole terms of part-time study, where teachers follow common work in both technical and professional fields; learning about a range of applications on different systems and exploring possibilities in the classroom for example. Other elements are more specialised; one example could be a twenty hour course on working with infants on model making and possibilities of applying computer control. Such shorter elements, open to any interested teacher, can come from a pattern of local short courses given by other agencies but available also as an optional component for the potential advisory teachers on long courses. Full-time weeks, and releasing course members from a normal teaching load in order to carry out projects in their own schools are also features which can be very useful.

CONCLUSIONS

The pattern of a mixed variety of course elements to meet a wide range of requirements tends to suggest that modularisation and credit accumulation is a sensible way forward. There is also, however, considerable merit in having a long course where teachers from twenty different establishments work closely together over an extended period.

There are immeasurable gains from discussion of views with other course members and with the many different contributors to seminars. Teachers on such courses can be seen to "grow" both in the way that they can contribute in discussion of the use of I.T. and in the professional contribution they can make to their schools.

It is important that long courses for advisory teachers should not just provide technical knowledge and skills. Those planning such courses should be aware of the needs of teachers and schools. They then have to provide a very wide range of experiences using local resources. It is not an easy task.

IN-SERVICE TEACHER TRAINING FOR COMPUTER STUDIES/LITERACY:

THE HONG KONG EXPERIENCE

Douglas S. Tung*.

ABSTRACT

This paper presents an overview of the development of computer studies and computer literacy courses in the Hong Kong secondary schools. Since 1980, conversion courses have been offered to in-service teachers, preparing them to teach the subject.

Over the years, some strategies have been formulated to promote in-service teacher training for computer studies/literacy. The Computer Education Centre was established to provide computer literacy courses to teachers, and to serve as a library of computer software, books and audio-visual aids. Meanwhile, bridging the gap between the computing practitioners and the teaching profession helps in the in-service teacher training programme.

THE ENVIRONMENT

In 1982, the Hong Kong Government launched the Computer Studies Pilot Scheme in 30 secondary schools at Forms 4 and 5 (Grades 9 and 10). Due to the success of the scheme, the number of participating schools increased to 294 (out of a total of 331) in September 1987, and the government had provided computer equipment worth £2.2 million. The number of students currently taking the subject is estimated to be around 13,000. The computer studies course leads to a Hong Kong Certificate of Elementary Education examination. It concentrates on teaching the concepts of computing, how computers function, programming in BASIC, computer operation and computers in the modern world.

In September 1987, a new computer literacy course for Forms 1-3 (Grade 6-8) was introduced at 70 government secondary schools for the Form 1 students. Its objectives are to teach students how computers affect society, how they can be used effectively, and about data processing and applications.

THE NEED FOR TEACHER TRAINING

Back in 1980, it was realized that the future of computers in schools would be dependent upon the development of a large cadre of highly skilled teachers (ref 1). The Department of Computer Science of The Chinese University of Hong Kong in conjunction with the Education Department of the Hong Kong Government offered Certificate Cource on Computer Studies for Secondary Schools Teachers from in 1980. This course proved to be very popular and has been repeated six times. So far, there are around 200 teachers awarded the qualifications.

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A survey on the characteristics of the computer studies teachers revealed that most teachers did not take computer science in the undergraduate years (ref 2). They had mathematics/physics education background. Many of them took up the teaching of the subject because they had a keen interest in the new technology.

The Education Department of the Hong Kong Government took the position that the deployment of teachers for computer studies would be at the discretion of the school, but in considering suitability, principals were advised to take the following qualifications into account.

(1) a recognized degree in computer science,
(2) a professionally recognized diploma or certificate in computing,
(3) a qualification obtained from a certificated extra-mural course in computer studies.

IDENTIFICATION OF THE BARRIERS

Over the years, there have been numerous discussions among the author and the in-service teachers on various aspects of promoting computer studies/literacy in the secondary schools. In fact, computer studies/literacy is similar to civics education in that it can be taken as a kind of culture. If computers can be integrated in the school environment and teachers are computer literate, they will use computers naturally in their work, then the culture will be passed on to the students.

Becoming computer literate is a developmental process (ref 3). It is important to identify the barriers which obstruct the process. The following barriers have been identified.

(1) Objectives are not clearly or accurately defined.
Teachers do not realize the benefits from using computers in the courses they teach. Some teachers think that they have to learn programming so as to use the computers. Their enthusiasm is dampened when they discover that to produce something useful by programming is not easy.

(2) Computer phobia.
The fear of the unknown is deeply ingrained in the human psyche. This problem is even more acute among the teachers who have great anxiety not to make fool of themselves in front of their colleagues or students.

(3) Difficult to start and lack of follow-up help.
The great variety of hardware and software causes confusion to beginners. The teachers do not have enough follow-up helps to the technical problems they encounter. Furthermore, when they are involved with learning and using the computers, their family lives will suffer.

(4) Lack of convenient access to hardware/software.
Teachers who are not currently teaching computer studies, or possessing microcomputers at home will have difficulty in the access to hardware/software.

(5) Lack of support from the school principals and colleagues.
The support is in terms of encouragement, resource allocation and collaboration.

(6) Short of experts.
Without the communications between the data processing practitioners, teachers find that it is difficult to understand the real-world activities and the recent development of the subject matter in the local scenario.

THE STRATEGIES

Some strategies have been formulated (with contributions from the teachers) to promote in-service training of teachers for computer studies/literacy.

In 1984, it was the feeling of all those concerned with the development of computer education in schools that a Computer Education Centre should be established by the Government to provide computer literacy courses to teachers, and to serve as library of computer software, books and audio-visual aids. The role played by the university in the in-service teacher training should be diminished because the university staff could not spend so much time in teaching the courses on a recurrent basis, and to devote more attention to the needs of the teachers.

At last, the £320,000 Computer Education Centre opened in December 1986. When fully operational, the Centre could organize 20 full-time and part-time courses to train 1,100 people a year. It serves also as a resource centre for teachers of other subjects who use computers. Along this line, courses are organized to get more teachers to have an appreciation of computers, for instance, in school administration and teaching. Our experiences revealed the fact that training science and non-science in-service teachers to understand computers are quite different. It is advisable to group them separately.

Since the primary concern of most users is to produce end results, and to obtain a sense of achievement. Most of the training should be directed towards user skills (ref 4). Instructors should guide the learners on a simple word processor or database package first. Once the learners have gained confidence, they will be motivated to try on something else.

One of the effective methods to minimize learner's anxiety is to conduct tutorials at home. The Computer Education Centre provides program clinics, electronic bulletin board and hotlines to help registered members. It is vital at any induction program to create an open atmosphere among learners, stressing that it is an "egoless" exercise in which learners feel free to disclose their difficulties and problems. Such re-orientation of attitude contributes much to the learning process.

In the school enviornment, computer equipment is usually regarded as the private assets of the computer studies unit. If possible, arrangements should be made to allow other teachers gaining access to the equipment. Around 300 computer studies teachers and schools principals have formed the Hong Kong Association For Computer Education. Enthusiastic members of the Association organise Special Interest Groups, such as LOGO programming and computer graphics. By joining these groups, in-service teachers can obtain the advice on the purchase of the right kind of hardware or software.

Since principals and school administrators decide on the policy matters, their knowledge and attitude will affect the use of computers in their schools. Appreciation courses will help them to be aware of the capabilities and limitations of the technology (ref 5).

It is essential to cultivate effective channels between the teachers and the computer practitioners. The Hong Kong Computer Society have organized joint functions with the Hong Kong Association For Computer Education to facilitate information transfer between the members of the two societies. Arrangements were made for the in-service teachers to take up summer jobs in computer installations, so that they could acquire an appreciation of the real-world data processing activities. Joint membership agreement between the two societies helps to foster fraternity among the members.

CONCLUDING REMARKS

Indubitably, there is a need to provide all people, especially the young generation, with some knowledge of the nature and uses of computers to live in the modern society. The first step is to make the teachers computer literate.

Becoming computer literate is a developmental process, and the barriers to the process have been identified. In this paper, some strategies to promote in-service training of teachers for computer studies/literacy have been discussed. In fact, positive measures, such as the establishment of the Computer Education Centre, and the cooperation between the Hong Kong Computer Society consisting of computer practitioners and the Hong Kong Association For Computer Education consisting of the teaching profession have been implemented.

Since the local industry leaders, the educators and the government all realize the importance of computers in the information based activities crucial to Hong Kong's economies, we can expect computer education is to flourish here, more and more in the coming decade.

REFERENCES

1. D.S. Tung, "Enhanced Thoughts on Computer Studies and Instructional Computing in Secondary Education in Hong Kong", Hong Kong Science Teachers Journal, 8, 1, pp. 77-83 (1980).
2. Y.S. Moon, D.S. Tung and J. Shin, "A Survey on the Secondary School Teachers in Computer Studies 83/84", Hong Kong Science Teachers Journal, 12, 1, pp. 106-112 (1984).
3. R. Anderson and D. Klassen, "A Conceptual Framework for Developing Computer Literacy Instruction", AEDS Journal, 14, 3, pp. 128-142 (1981).
4. B. Fary, "Computer Literacy for Staff Development", AEDS Journal, 17, 4, pp. 1-8 (1984).
5. Y.C. Tsao and W.W. Ki, "Strategies for Development of Computer Literacy Programmes for Teachers", Proc. of Information Technology Developments and Their Implications for ASAIHL Institutions, 2, pp. 478-490 (1986).

SCHOOLS OF THE FUTURE: 2020

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ABSTRACT

The objective of this paper is to illustrate some design, technological requirements, and instructional usage concepts which might well be present in state of the art schools in the year 2020.

The school of the future will be surely a site of teaching about the use of state of the art technology. The amount of technology innovation in the western world during the past several decades has far eclipsed the rest of the century and the future seems to portend even more fruitful and productive technology development.

THE PRESENT

Many thousands of school buildings, especially secondary schools are already obsolete to meet the needs of housing the proliferation of technology which has impacted curriculum, instructional methods and administration. A vast majority of U.S. schools were built before 1975 when birth rates and the number of school age children plummeted downward. Of course, in 1975 the impact of the computer on instruction and administration had just began to be felt in schools. Today a majority of elementary and secondary schools have not totally mechanized to fully utilize the technology which is available for effective instruction and training. Due to lack of funding and technical expertise, schools have sadly lagged behind in using state of the art technology in all aspects of the school operation.

THE PROBABLE SHAPE OF THE FUTURE

Certainly technological based training will quickly change the traditional education program of basic skills in language, mathematics, sciences, languages, in the 21st century as these subjects will be continued to be taught but in more technologically efficient ways. The current configuration, especially American schools, will change as slowly educators, bureaucrats and parents begin to understand that the knowledge explosion of the 20th century has nearly made it impossible to implement the present let alone the future curriculum within a school calendar constructed in a horseless carriage agarian society of the 19th century. Schools will be year round, provide a continuing wide range of social services, and increasingly prepare children for the next upward step in technological training. The pace of current technology requires children to be taught in technologies which by the time they exit the school program are obsolete. The giant problem of curriculum and instruction obsolence will become more acute in the 21st century and probably never be completely resolved.

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WHAT WILL 21ST CENTURY SCHOOLS LOOK LIKE?

The essence of educational facility planning is to place brick and mortar around a developed educational program. The brick and mortar configuration should not determine the nature of the educational program. The program first, the bricks second.

The educational programs and instructional techniques of the 21st century will be heavily impacted by electronic technology, therefore, the facilities themselves will be plumbed exceptionally well and for the most part incorporate designs required by that dominant operational characteristic. However, other technological requirements will also necessitate specific design considerations.

The overall physical design of school buildings will change not only due to the instructional mission but also because of advances in the development of various building materials, heating/cooling systems, energy conservation systems and as mentioned previously, electronics needs.

The Building Design

Several factors besides cost will influence the school design of the year 2020. Already today, efforts are being made to create facilities which are flexible and provide cost effective energy use. The scarcity of energy resources at present and in the future will do much to shape the design of school facilities. Even with the development of materials with good effective insulation properties, the construction of schools underground or substantially bermed will become a reality as both construction, maintenance, and energy costs can be dramatically reduced. This will be especially true when electronic systems no longer need cable transport. The problem facing many urban school districts is the availability of land for both building, parking, and athletic fields. The underground building allows for a much more efficient use of available land space.

The cost of energy will become an increasing problem unless solar and nuclear sources are more efficiently utilized. If this is the case, in 2020 more school designs might show multi-story shapes with heightened ceiling space and flexibility to allow for structural aesthetics. If energy costs continue to escalate the probability of highly bermed and underground designs will become realities.

The recycling of older facilities at this time almost seems an impossibility as the square foot remodeling costs to accomodate todays, let alone tomorrows technology, are sometimes more than new construction costs. In some cases partial recycling might be possible as some parts of facilities such as gyms might be reusable. Elementary schools possess more possibilities for retrofitting and remodeling.

Thermal Design

Research has shown that the quality of thermal environment affects the physical and mental comfort of students and teachers. Good thermal design allows for comfortable dissipation of normal body heat. Futuristic schools will be totally air conditioned not only for the comfort of the inhabitants but also to protect sensitive electronic equipment from both heat and dust. To obtain correct thermal design, the building shell will be constructed of materials which minimize heat gain and loss. Probable use of single ply roofing will also be a feature. Internal sound levels will also have to be considered in the thermal design as heating and cooling systems should not transmit sound above ambient noise levels. Current computer controlled heating /cooling HVAC systems will be continued to be developed and by the 21st century should be able to maintain control of thermal degrees in buildings without the current difficulties.

Visual Design

For most of the 20th century experts thought the amount of foot candles dictated how well a student could see in a classroom. The ability to see comfortably and efficiently does not increase in direct ratio to the quantity of light provided. Therefore, with students working on screens, boards, printed materials, and even perhaps more advanced optical products, the importance of properly designed environments becomes even more critical. Classrooms will in all likelihood have the ability to have adjusted luminous sectors which will facilitate the performance of different types of learning tasks. Rows of flourescent tubes will give way to much more sophisticated recessed lighting capable of forming "light screens" with individualized learning station adjustment. The question of natural lighting will probably be addressed in the overall external structural design and be provided to meet the needs of human psychology.

In an electronically driven and dominated learning environment the problem of reflectance will become extremely important and colors and textures of wall and ceiling surfaces along with furniture will have to be carefully monitored by designers. Correct levels of brightness and contrast rendition with light sources will be critical in order to create learner comfort.

Sonic/Acoustical Design

Sound as a factor in school building design is both a negative and positive factor. The design must be that which facilitates the transmission of wanted sound effectively, such as that from voice, equipment and instruments. The elimination and suppression of unwanted sounds is an expensive negative sonic design problem. In a school instruction design which promotes electronic usage and individualized instruction the furnishings and equipment will have to be developed which are sound absorbative, free of flutter tumble echo, and which remove exterior noise. Schools of the future will be constructed with mostly "soft" materials and perhaps electronic "deadening" devices will be developed to further the control of unwanted exterior and interior sound within the learning environment. The external noise will in likelihood be controlled by orientation of the structure, minimal number of windows, plantings, landscaping, double glazing, and use of absorbative materials on the exterior of the building such as fiberglass coverings mounted on screens attached to concrete block.

Education Design

The essence of good educational design now and in the future is flexibility. The design has to possess the capabilities to house programs in a useful lifespan of perhaps forty to fifty years. As schools move into the 21st century the demands for design flexibility will become even more stringent than at present because of changing technologies. The writer is sure that in the 1930's educators in classrooms either debunked or could not visualize that the content of the comic strip "Buck Rodgers" with laser guns, travel to the moon, and intercontinental ballistic missiles would become realities within their own lifespan. Few educators spend much time in future planning probable 21st century events such as the use of robotics in instruction, and comprehensive computer learning rather than today's computer assisted learning.

In order to operationalize an electronically based curriculum which will likely take place in a number of specialized instructional areas, learning modules which are knowledge based will likely be taught in large interactive television type classrooms while more specialized skill types of learning will occur in less flexible spaces such as laboratories, computer centers, and learning resource centers, perhaps under the partial tutelage of robots assisting the instructor who may or may not be physically present.

The transport systems to provide for an integrated systems network at present is compliacated but will in the future be less so as digital technology improves. The many cables needed to service the facility will in all likelihood be designed beneath floors perhaps in plastic sheaths easily removable in large sections. This means that large concrete slab floors will most likely yield to more flexible floor surfaces with perhaps even deadened and raised spaces for both transport system access as well as acoustic and thermal inserts.

Baseband and broadband-systems will be used in classrooms for video and sound communication. Classrooms will be originating points of communication or points of interaction. Students in the knowledge based type of classrooms will have PC-AT's which will be queued to VCR's. The effect of the systems will be to provide learners and instructors access to a complete educational utility concept for interaction which can be monitored for learning capture. The utility would be a world wide satellite network feeding to all users. An instructor in London will teach English History to students in Seattle.

Also the possibility of schools possessing capability to utilize transmit-receive antennas to interact and instruct children at home possessing PC's capable either using commercial utility lines or receiving school transmissions might well prove to be the most useful mission of the school of 2020. The effect of such a system on the school facility would be likely to diminish the number of students inhabiting the building and diminish per pupil costs.

AN AGENDA FOR EDUCATIONAL LEADERS IN THE FUTURE

DR. NOLAN ESTES*

ABSTRACT

The challenge facing us today as educational leaders is to develop our most valuable asset: the human potential of all children of all people to benefit from the new information technolgy and to ultimately help us achieve a more peaceful and just world. If education is to respond to the 21st century and the Information Society the school leaders of today must challenge themselves to enter into new administrative arrangements, new organizational patterns, new collabrative decision making models, and adopt new metaphors of teaching and learning. They must except the challenge to become truly computer literate and develop the capacity for change.

INTRODUCTION

We are quickly marching into the 21st century, where information will be the currency of the realm. Education, as never before, is being challenged to fully develop our most valuable assest, human potential. The question that remains is whether or not education and its leaders are ready and able to meet this challenge. If not, the consequences are clear: business or private enterprise will take possession of the strategic resources of the new age and provide direction for our nation's future into the 21st century.

As educational leaders, the most pervasive issue we must grapple with is: we can continue business as usual, and remain on the edge of a crisis; or, we can make nothing less than a paradigm shift in our thinking and thus prepare the youth of today to be able to respond to the opportunities that will be presented in the 21st century.

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If education is to respond to the opportunities presented in the information age, a radical organizational restructuring is required. The outmoded hierarchial arrangement which has served education in the past must give way to a leaner more fluid horizontal structure. Collegial decision making cores, extending into building units, will be formed to provide support and direction to peer coaching and review teams charged with evaluation, promotion, hiring and firing. Teachers will be enhaced professionaly under this new horizontal structure.

As educational leaders we must foster a dramatic shift in the nature of teaching and learning. Teachers of the 21st century will no longer be the dispensers of information, but will be the coachs and experienced guides who meet the need for human touch. Computers will tutor students either at the home or at school in basic skills, simulated analysis, synthesis, and creative problem-solving; teachers will emphasize the arts and humanities. and coach students in skills required to access information and develop higher order thinking skills. Computers will never replace teachers, but the teachers who care, who build involvement with their students, and are themselves creatively engaged in using the new technolgies, will function the best in the coming new age. The new age will require educators to value questioning, exploration, creativity, problem solving and decision-making in uncertain environments. The new age society will demand new administrative arrangements, new organizational patterns and new metaphors of teaching and learning. Are you, as educational leaders, ready to address this challenge?

THE CHALLENGE

To accept the challenge of the Information age, educational leaders must harken to the clarion call for administrators to become computer literate--sufficiently literate to be able to ask those who input information to do it in a way that will enable the administrators to answer the necessary questions. They need to be sufficiently computer literate to know the full range of capabilities of computers so that they can plan to use them for access to information bases, teleconferencing, automatic data transmission and receipt after hours, database management, scheduling, word processing, and so on, and sufficiently literate to strategically plan to increase the computing capabilities of their school in a systematic, incremental way.

To make the transition to an information age, perhaps no skill will serve educational administrators as well as the ability to manage change. Annison (1982) notes that educators' "responsibilities are no heavier than they have been in the past. What is terribly difficult about it is that you are still running institutions that are rooted in cultures and traditions of the two societies that are gone" with fixed periods and rigid curricula. It is going to come down to "your personal behavior today, tomorrow, next week, and next month." The agenda for educators to make the transition to the information age calls for us to:

1. Learn from the future.
2. Build a vision of what we want to do.
3. Learn to be comfortable with chaos.
4. Take this once-in-a lifetime opportunity and run with it.

The critical questions we must ask are: What capacity does the school system have to adapt to the volcanic eruption of new technologies and new industries? To make creative leaps from where it is now to where it will be in the future? To solve complex, nested problems? And finally what capacity does the school system have to make the needed capital investments? These then are the challenges. As you prepare to meet them, you might keep these thoughts in mind: "Revolutions Never Retreat." (ref 1) and "Dogs and Computers can Smell Fear" (ref 2).

1. "A New Era for Management" *Business Week* , (April 25, 1983) pp. 50-80.
2. Robert Gillespie, "Computing and Higher Education: The Revolution is through the Gates." *Forum* , V, no. 6, (1983).

TEACHERS, STUDENTS, AND COMPUTERS IN THE FUTURE

June St.Clair Atkinson

ABSTRACT

Computer technology is available to change the teacher's role in helping students learn. Some of the computer technology can be used effectively. In other cases, we have yet to figure out how to use it or the technology itself is in the research and developmental stages. Although the acceptance and utilization of these technologies are not widespread, some educational and business training programs have been using them. Without a doubt, computer technology is abundant. The question is, Are we being prepared to take advantage of it in the educational setting--in our academic and vocational courses? Will we be prepared in the future?

Computer technologies holding great promise for the classroom of tomorrow are expert systems, including voice input and recognition; telecommunications, and simulations.

SCENARIO

Daydream for a moment and picture yourself in a classroom in the year 2010. You see students in cubicles that remind you of a television studio. The computers, small as they are, are laser-driven and voice activated. You rarely see any paper. Students easily change data on the computer screen through a portable laser pen. Students are given immediate feedback and evaluation about their work. A teacher is in the vicinity working with a small group of students, but other teachers on that school's faculty are physically located in all parts of the world. They teach lessons via telecommunications.

You don't see paper textbooks. Instead, each student has an apparatus about the size of a paperback book that contains all of the information in the U.S. Library of Congress (Christopher Evans in his book, Micro Millennium, was right when he made that prediction in 1979.) The student's access to the world's most famous libraries is a "button" or a "word" away.

Visit the classroom where occupational skills are taught. Instead of large pieces of equipment, you see students learning job skills via computer simulations. The simulations are representative of systems involving computer-integrated manufacturing, information management and technology, medical prognosis and treatment, automated marketing, environmental, personal and consumer services. Students practice skills and engage in problem solving and creativity-building techniques before encountering equipment or people. You will see teachers working closely with students in building social and communication skills. After all, oral communication is the main input device to machines and people. Expert systems also diagnose students' strengths and weaknesses. They then prescribe activities or strategies that the student must use to overcome weaknesses.

Take a look at the foreign language class. In one corner a student is practicing her/his French enunication. The computer "listens" and "corrects" the student. Another student is conversing with a Spanish girl who lives three thousand miles away. What the Spanish girl says is immediately printed on the computer screen, just in case the student doesn't understand.

In another part of the school, teachers are working with technicians in developing expert systems and programming them for the upcoming telecommunications lessons. They are using their own language in devising programs to supplement those that are already in the hardware-software blend of a computer. You will also find some teachers discussing with administrators, such topics as: What skills do students need for tomorrow's world? What is intelligence? How do we teach thinking skills?

PREPARATION FOR THE FUTURE

How can the educational community prepare for this future scenario? Here are some steps we can take:

1. View computer technology as an assistant to rather than the primary deliverer of education.
2. Keep up to date about new computer technology. Examine the technology in terms of how it can help with educational delivery.
3. Prepare teachers to be managers of instruction.
4. Introduce new tools and concepts before they become widely used. This strategy helps to create the proper awareness or attitude toward the technology.
5. Encourage and teach instructors to experiment with new computer technology that will help make their teaching more effective and efficient.
6. Try proven solutions. Set up demonstration sites. Publicize the activities and program.
7. Work closely with business and government or others who are in the forefront.
8. Do not underestimate the need for people in the educational process.
9. Beware of computer technology limitations.

INSTRUCTIONAL DESIGN, COGNITIVE PSYCHOLOGY AND THE DEVELOPMENT OF COMPUTER-MEDIATED LEARNING MATERIALS FOR COMMUNICATION IMPAIRED CHILDREN

D.F. Sewell*

ABSTRACT

This paper is concerned with two main themes:

a) an examination of the potential and actual influence of cognitive theory and instructional design, especially in the context of communication impaired children;

b) a description of a research project, designed in this context, involving the development of "interactive" learning materials for use with severely learning disabled children.

INTRODUCTION AND RATIONALE

The history of the relationship between theory and practice in education is largely one of dogmatic assertion from the theoretician on one side and understandable scepticism from the practitioner on the other. In many respects, it appears that those involved in the theoretical issues of learning and cognitive development have often failed to demonstrate clearly the practical utility of their work to teachers and other professionals despite Neisser's assertion (ref 1) that "a psychology that cannot interpret ordinary experience is ignoring almost the whole range of its subject matter." More recently, Middleton and Edwards (ref 2) have stated that the "theoretical base of psychology has to be capable of addressing issues of importance to real people inhabiting a real world."

These issues become of particular significance in an educational context where the educator can exercise considerable control over the structure of the learning environment. Such control exists in an accentuated form when:

a. the learner has a handicapping condition which limits interaction with conventional learning environments, or

b. the learner environment can be structured by the use of powerful and flexible educational technologies.

Where both the above conditions apply one would anticipate the need for a sophisticated understanding of learning theory to be acute. Such a situation exists in the case of severely learning impaired children where a combination of sensory, motor and cognitive impairments drastically restricts the potential for interaction with the surrounding environment.

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Despite the fact that modern learning theory emphasises the significance of active involvement with the environment in influencing learning and cognitive development, the application of modern technology to the problems of the handicapped has largely taken place in what might be termed a "theoretical vacuum". Although considerable enthusiasm has been expressed for the use of technology with such groups, much of the reported work is characterised by an implicit adherence to a simplistic interpretation and application of a behaviourist approach to learning, with emphasis on passivity, rote learning and drill and practice. Chandler (ref 3) has described such materials as "crude behaviourism in a seductive new guise". Although such approaches can be useful in rehearsing newly acquired skills, they do little justice to the potential flexibility and power of the technology, nor do they reflect the shift away from behaviourist stimulus-response psychology to cognitive learning models with their emphasis on active transformations of incoming materials. However,although such cognitive models now occupy a dominant position in modern psychology, they often lack an obvious prescriptive element which would enable them to be transformed into practical models which could be applied in real world situations. Notwithstanding this criticism of the gap which exists between cognitive theory and educational practice, modern cognitive learning theory provides a potentially powerful paradigm, particularly when placed in conjunction with practical models of instructional design. Such models can provide prescriptive guidance on how learning and training tasks can be designed in order to optimise learning, although, in many instances, the models have been developed with reference to industrial and military training and have not incorporated developments in cognitive theory. However, Reigeluth (ref 4) points out that the practical aspects of instructional design hold considerable promise for education, a claim which Mayer (ref 5) has also made for cognitive science. What appears to be required is an approach which seeks to combine the prescriptive power of instructional design with the theorectical aspects of cognitive learning theory. The work reported in this paper represents a preliminary attempt to apply such an approach to the use of modern technology with children in need of special educational care.

PROJECT DESCRIPTION

Although each handicapping condition is accompanied by a unique set of problems, underlying each impairment is a restriction in the quality and quantity of interaction with the environment. One consequence of such restricted interaction is that the development of adequate "internal models" of the world is also restricted. The challenge for the educational technologist is therefore to design learning environments which encourage interaction and which enable individuals both to demonstrate existing capabilities as well as to develop their true potential.

Work being carried out by the Educational Technology Research Group in the Psychology Department at Hull University is addressing the problem of the development and application of modern technology to children who experience severe learning difficulties. These children demonstrate considerable problems in the acquisition of a range of simple conceptual skills (e.g. difficulties with colour, shape, position, size and sequencing). Further difficulties exist in the acquisition of basic linguistic abilities (e.g. comprehension and listening skills; elementary converstional principles; expressive skills and goal directed questioning behaviour). When placed with the limited attention and memory skills also characteristic of such children there are inevitable implications for the children's ability to master multiple concept and simple problem solving activities involving the acquisition and retention of relevant information.

The children described represent a grouping which manifests a set of problems necessitating special educational provision. Traditional education for these children has concentrated on the provision of carefully structured and individualised instruction wherever possible. Although individualisation and structure are characteristics frequently associated with computer-aided learning, and are in accordance with fundamental principles of instructional design, they are also frequently associated with placing children in passive learning situations which are at variance with current cognitive models. In addition, such educational software as is available for use with this group perpetuates passivity by being mainly of the "drill and practice" format with little opportunity for the children to initiate actions and decisions and to perceive the consequence of their actions.

In order to place the children in a more active learning situation, as well as to present a series of activities which target the learning difficulties experienced, a suite of software has been developed which covers a range of skills varying from simple to complex. The programs in the suite deal with cause and effect relationships; discrimination of available responses; use and mastery of single concepts; conjunction of two concepts; conjunction of three concepts, and the analysis and synthesis of concepts in a problem solving task. The software has been designed to "step up" the relevant skills in a hierarchical manner in which the skills used at each particular level incorporate those covered at preceding levels of complexity, together with the new skill. Interaction with the progams is by the use of a Concept Keyboard, and the need for good reading skills is eliminated by the use of speech synthesis.

Use of the software has indicated that children initially having difficulty with the skills dealt with by the software are able to master the tasks presented following experience of the programs.

CONCLUSION

The work being carried out is designed both to meet the needs of the group as well as to present a meaningful cognitive challenge.

The underlying rationale is strongly influenced by cognitive psychology which has resulted in an emphasis on interaction, a feature often stated to be a unique potential feature of modern technology. In addition, a strong element of structure is introduced to the learning environments which provide situations and tasks which are accessible to existing skills and abilities. The material described not only enables the users to utilise abilities already possessed, but also permits the development of new skills relying upon the utilization of simpler skills. The hierarchical nature of the materials owes much to the influence of instructional design theory which emphasises that in order to attain particular learning objectives it is essential to analyse task demands, the skills required and the user's existing abilities. The work described draws on the relative strengths of both instructional design and cognitive psychology in order to enable cognitively impaired children to express the skills they have, and, more significantly, to develop those skills in order to attain more sophisticated abilities.

REFERENCES

1. U. Neisser, Cognition and Reality: Principles and Implications of Cognitive Science (Freeman, San Francisco, 1976).

2. D. Middleton and D. Edwards, Bull Brit Psychol Soc, 38, 146-150 (1985).

3. D. Chandler, Young Learners and the Micro-computer (Open University Press, Milton Keynes, 1984).

4. C.M. Reigeluth, Instructional Design Theories and Models: An Overview of Their Current Status (Lawrence Erlbaum Assoc., Hillsdale, 1983).

5. R.E. Mayer, Educational Psychology: A Cognitive Approach (Little, Brown & Co., Boston, 1987).

Information Technology & Special Needs in Education.

J. Pickering*, D. Neilson* & C. Vella+.

ABSTRACT

The paper discusses some theoretical and practical problems in using information technology to help people with Special Needs with some aspects of education. The paper reports the progress on two projects and some findings from a recent survey on Information Technology and Special Needs.

INTRODUCTION.

Possibly the most immediate consequence of severe physical handicap on the educational process is the imposition of a slow rate of work on the handicapped student. Almost all aspects of the student's work are slowed in particular, writing, drawing, information finding and reading.

With the increasing power of affordable small computers and the increased capacity of rapid-access mass storage devices such as hard disks and CD-ROMs, it should now be possible to use this technology to increase the rate at which the physically disabled student can perform the educationally vital activities noted above.

The necessary equipment and systems are being developed rapidly by the information technology industry, though not necessarily with Special Needs in mind. Each year brings new systems or software with clear Special Needs potential.

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Those working in Special Needs might regard this increasingly sophisticated array of equipment as a toolkit from which items can be assembled into systems matching the needs and capacities of the disabled. This assembly will require a variety of research skills and techniques. Some will be required to integrate different systems while others will be required to fit the resulting hybrid systems to target users or user groups. The former skills and techniques are primarily technological while the latter are ergonomic and psychological. Contemporary Psychology departments, where Computer Science and Artificial Intelligence are playing an increasingly influential role, are ideal environments for such research. The following are two projects currently under way at Warwick Psychology Department and some preliminary results from a survey of the Special Needs community.

THE INTELLIGENT WORD PROCESSOR

This project aims to produce a text-production system helping those with severely impaired keyboard skills. The system will supply menus of text-fragments according to the context and displayed at appropriate points during the character by character input.

The contextual information used to produce predictions will include word frequency and recency, syntactic rules and knowledge of the domain or subject being written about.

Once the software representation of these various information types has been chosen then their individual contributions will need to be co-ordinated to make useful and rapid predictions.

There are many questions to be answered regarding the presentation of menus, the most important of these are:

> the position on the screen where the menu appears;
> the maximum number of items in any one menu;
> the order in which the menu items are listed;
> the method by which selection is made.

To make the system an effective support to text production, the following design goals have been set: The system will produce a prediction menu in a period suited to the input rate of the particular user. This rate may change over time and the system must adapt itself accordingly. The aim here is that the system should adjust to match the user and not vice versa, while the quality of the prediction menu comes second.

One type of information that the system will make use of in producing predictions will be specific to the individual user. Characteristics such as typical vocabulary together with other idiosyncracies will be used. Since such data changes over time, the system must be capable of learning about these changes itself and up-dating the user-specific information accordingly.

The system must afford the user a degree of control over those aspects which have no universally agreed "best method". It has yet to be determined what all these aspects are, but they will include such things as menu format and selection method.

INCREASING SEARCH SPEED.

The second project continues this theme of user customisation. Many disabled people employ some form of multiway or single switch instead. Using the limited set of signals which can be sent to select from a large set of option requires good search software but however well this may be written the process of selection can often be laborious and frustrating for the user.

The speed of the process is determined both by the limitations of the switch operation and by the difficulty of deciding where in the search space the desired option is. Many systems attempt to arrange options to minimise the selection effort but do not take sufficient account of the difficulty in deciding on an efficient sequence of actions. Individual users vary widely in their perception of any given system and it seems likely that there will be no optimal arrangement that will suit all users. Accordingly, work is in progress on a system that allows users to retain, discard and arrange any given set of options in order to configure the system to their requirements.

TECHNOLOGY AND SPECIAL NEEDS SURVEY

A small-scale questionaire survey has been carried out between October 1987 and March 1988 directed at users, researchers, teachers and support agencies involved in the Special Needs area. The response rate has been good and the following are some preliminary findings.

Responses show those involved in research and development for Special Needs range from companies who are marketing particular devices to "one-man-band" inventors who develop specific aids for the individual on their own with little or no funding.The support provided by the various aids covers:

environmental control;
spoken communication;
text production;
education;
home working.

The intended users include those with spinal cord injuries, stroke victims, quadraplegic and tetraplegic patients plus severely mentally handicapped children and adults.

Returns from users indicate that currently available systems are felt to be slow and frustrating to use. There was widespread agreement on the need for customisability and to extend the capacity for independent use of systems for such things as environmental control, telephone control, access to libraries, on-line databases and other aspects of home working.

DESIGN ISSUES IN THE USE OF ROBOTS AS COGNITIVE ENHANCEMENT AIDS

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ABSTRACT

Robotic manipulators are being used in an investigation of their potential as effective classroom learning aids when used by severely orthopedically disabled children to manipulate educational materials and to play games. During the course of the design and development of a prototype robotic system for educational use, several issues have surfaced that constitute serious considerations in the process. Of particular importance are issues involving accessibility, software design, curriculum integration and specific research questions involving spatial visualization. Performance data from previous investigations has shown that learning to use robots can be easily accomplished and that the consequent learning is remarkably resistant to decay over time.

INTRODUCTION

Robots have been used effectively in a number of different rehabilitation settings as prosthetic aids by spinal cord injury patients (Leifer, ref [1]). Other investigations have applied robotic technologies to vocational applications (Foulds, ref [2]). Kwee (ref [3]) discusses several critical issues in robotics implementation in France and the Netherlands which have isolated several important features of such systems within the areas of the "man-machine interface" and control "languages". However, very little work has been done with school age children experiencing neuromuscular disabilities such as cerebral palsy, muscular dystrophy and other pre- or post natal traumas (Hoseit, et al, ref [4] ; Howell, et al., ref [5]). At issue in the educational realm is the relevance of using robots in the

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[1]. L. Leifer, Robotics for the Disabled, Rehab. Rsh & Dev. Center, 1983

[2]. R. Foulds, Interactive Robotic Aids, World Rehab. Fund, Inc., 1986

[3]. H. Kwee, Spartacus and Manus..., Interactive Robotic Aids, World Rehab. Fund,1986

[4]. K. Hosiet,N. Liu,& a. Cook, Development and use of a robotic arm system with very young developmentally delayed children. Proceedings: 9th Annual RESNA Conf., 1986

[5]. R. Howell, S. Damarin, & P. Post. The use of robotic manipualtors as cognitive and physical prosthetic aids. Proceedings: 10th Annual RESNA Conf., 1987.

and the potential for increased cognitive development when the disabled person is young and experiencing school difficulties that are a direct result of their inability to explore and manipulate their external environment. It is within this exploratory realm that the robotic manipulator might find one of its most useful applications.

DESIGN OF THE STUDY

Research Questions and Related Methodologies

The primary research question guiding this research initiative involve an investigation of the cognitive and affective impacts of using robotic devices within an educational environment. Research questions have been developed in four main areas to answer the overall goals: (1) cognitive issues - visual/spatial skills, (2) cognitive/educational issues - accessibility to educational materials, (3) affective issues - locus-of-control and attitudes, (4) environmental issues - the educational robotic environment.

The research methodology utilized in this research attempts to integrate both qualitative and quantitative approaches in order to answer interactional and specific performance-based questions in the course of the student/robot interaction. The quantitative approach involves the use of a "changing criterion" single-subject design that provides an opportunity to investigate the individual response patterns of each student as criterion for success change over time, with each student acting as their own control. The qualitative approach involves the use of field-based observations, structured surveys, video-taping, and anecdotal information which will be analyzed, categorized and summarized in order to provide a comprehensive view of the interactional nature of the educational robotic environment.

Hardware Specifications

This project is also concerned with prototype development of a complete educational robotic system in which the hardware demonstrates several important features, including: (1) adaptability/flexibility, (2) mechanical/electronic integrity, and (3) cost effectiveness. The first level prototype robotic system used an Apple IIe computer, a Rhino XR-3 Robot, and a Prentke-Romich 5-slot adaptive interface device. The second level prototype (in the design stage at present) consists of an IBM PC-AT, a UMI RTX Robot (SCARA configuration), and a combination of adaptive interfaces including joystick, a "Lighttalker" communication device (Prentke-Romich Co.), and multiple switch devices.

Software Specifications

The primary issues involved in providing the user control over the robot exist as an interplay between direct access and software control methods. In all instances, the use of direct access control methods is preferred as long as the desired control over the environment can be carried out effectively and efficiently. However, direct control does not necessarily allow for the development of cognitive skills leading to the ability to develop complex, multi-step strategies over those situations that involve manipulation in unstructured environments or to control movements that are of high frequency and repetitive in nature. In order for the user to develop procedures for such types of control, some type of programming environment must exist for the user to construct and store programs that can be executed in a simple fashion.

Finally, control software must allow the user to access commands that allow robotic movement in three-dimensional space: 1) axis control, 2) vector control, and 3) position control. *Axis control* involves movement of the robot by commands that indicate the degree of rotational movement of a specific robot axis point. *Vector control* involves movement of the robot by commands that indicate a direction and a distance increment or decrement. Finally, *Position Control* involves movement of the robot by commands that indicate a desired end position in a pre-defined, structured environment.

Curriculum, Training, and Educational Considerations

The curriculum for developing skills with robots involves two distinct, but interrelated, approaches that are sequential in nature. First, the student must be trained to use the robot in a simple, effective manner. The primary goal of such training is to develop more automaticity in the performance of critical skills in using the adaptive interface devices and the robotic manipulator. Secondly, the student must learn to use the robot in educational activities in which the robot becomes another tool in an exploratory-based environment. This aspect of curriculum development involves the implementation of an educational program that uses the robot effectively. Our project has selected to attempt to develop inquiry skills and techniques using the content and methods of scientific investigation as the specific educational intervention.

The goals of the Training Phase of the curriculum are:

Goal #1: Begin to establish the motor competency in manipulating the robotic arm.

Goal #2: Begin to establish cognitive automaticity in manipulating the robotic arm.

Goal #3: Begin to establish positive affective attributes in manipulating the robotic arm.

The goals of the Educational Phase of the curriculum are:

Goal #4: Emphasize the scientific process, utilizing appropriate questioning techniques, hypothesis generation, and related concepts within the context of a rich exploratory robotic environment.

Goal #5: Use existing (conventional) materials with few, or minimal, modifications whenever possible.

Goal #6: Provide a sequenced set of activities that develop an integrated knowledge of specific science concepts and related methods of investigation.

IMPLICATIONS OF THE RESEARCH

The focus of this research is on the delineation of issues related to the educational applications of robotic devices. The use of the robot within well-designed instructional environments may provide new opportunities for learning by severely orthopedically disabled students. With this new learning comes the advantages of cognitive and affective growth that could positively affect the overall development of the individual. The obvious benefits of early learning experiences in controlling and manipulating the educational environment may significantly enhance the quality of life of the severely orthopedically disabled individual.

USING COMPUTERS TO TEACH ENGLISH COMPOSITION: WHAT ARE THE RESULTS?

B. Cummings*

ABSTRACT

This paper explains how computers can be used to transform the traditional composition classroom, with its emphasis on lectures, passive learning, the study of grammar, and the emulation of prose models, into a composing workshop where students learn to write by writing, revising, and collaborating with peers. In the writing workshop, which is student-centered and process-oriented, computers facilitate the redefinition of student-teacher roles, expectations, responsibilities, and relationships. This presentation includes a video tape of the implementation of this model and the concomitant changes in students' composing behavior and writing competencies.

Researchers and theorists in the field of English composition define writing as a process consisting of three recursive stages--invention, writing, and revision. Underpinning this process, the researchers say, is a set of complex cognitive maneuvers: the writer, as he/she attempts to discover his/her purpose and to shape his/her message for an audience, retrieves and categorizes information; gropes; hypothesizes; considers his/her conclusions in light of his/her anticipated responses of his/her reader; searches for relationships; and analyzes, synthesizes, and evaluates ideas. The pedagogical implications of this research are obvious: composition students should be taught the writing process; they should be allowed to learn to write by writing--using heuristics, making preliminary drafts, receiving feedback from the instructor and peers, revising copiously, and experimenting with language.

Within the last four years, microcomputers have revolutionized the ways in which writing is learned and taught at many institutions of higher learning in the United States:

1. The microcomputer transforms the traditional classroom into a composing workshop where students spend class time writing, talk freely about their writing, pace themselves, and copiously revise their papers as they consult the instructor and their peers. Since the words scroll up and down the

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1. Cont.

   screen, move from left to right, fill up the computer screen, diminish as the delete function is activated, the students perceive their texts as fluid. Thus, the students' reluctance to delete text that they have developed as a result of much groping and effort, gradually abates. Indeed, the students learn quickly that writing is discovery, that it is revision, that it is thinking, that it is a process.

2. When microcomputers are integrated into the learning environment, teacher-student roles, relationships, and expectations are redefined. The teacher now assumes the role of a facilitator, encouraging students to experiment, to raise questions, to take risks, to give and to seek help from peers and the teacher. The teacher also functions as an audience who models a critical thinking paradigm, who asks for clarification, who allows the writer to change his/her text at any time in the writing process, who guides and directs at the propitious moment, who understands that writing entails discovery, groping, experimentation, and risk taking, who exudes respect for the student writer's opinions, observations, and experiences. And the students, as they compose on the computers, expect others to read over their shoulders, for the writing on the screens makes the composition process a social activity.

3. The emphasis of the writing curriculum shifts from grading papers and lecturing to teaching the process of composing. The students no longer listen lethargically and passively to lectures. The teacher no longer spends inordinate time and effort scouring papers for every comma splice and run-on. Students no longer anticipate throwing their graded (bludgeoned) papers into the trash cans. Students expect to revise their texts. The teacher now grades the entire process (the false starts, the notes, the lists of ideas, the groping, the writer's response to the feedback, the preliminary and final drafts). She is interested in what works in the drafts, what does not work, where the student has faltered in the process, and why the student writer has not considered the demands and expectations of the audience.

4. Because students are immersed in the process of writing, the focus of the curriculum is the acquisition and honing of higher level cognitive skills--analysis, application, synthesis, and evaluation. As they write and revise on the

4. Cont.

> computer screen and submit various hard copies of their texts, students are incessantly bombarded with questions from peers and the teacher: What about this fact? How did you reach that conclusion? Have you thought about this? Where is your proof? Where are your examples? How did we get here? Does this make sense? Does this prove that? Is this the most effective pattern of development? Are you trying to state a relationship here? What is the connection between these sentences, between these paragraphs? Indeed, the students readily seek such feedback in order to evaluate their texts in light of the reader's demands and expectations.

Computer technology has been integrated into composition courses without mechanizing the teaching and learning of the composing process, for CAI materials are not the panacea for students' writing problems. Nor have computers isolated students from each other or from the teacher. As a matter of fact, the computer affords students an interactive, active, positive and ego-satisfying educational experience, that is, when the technology is used as a revision tool. A simple word processing program encourages students to experiment with language, to view writing as a dynamic process, to consider composing as an interactive and public activity, and to perceive revision as a new vision or reformulation of ideas, concepts, and relationships. When the microcomputer is used as a tool in the writing process, the composition classroom truly becomes a stimulating environment, where students become highly motivated and productive, actively engage in the process of writing, learn to consider the perspective of the audience, experiment with linguistic constructions, and spend class time working through successive drafts as they receive feedback. Most important, the students' composing behavior changes and their writing improves.

DESIGNING WORD PROCESSOR BASED WRITING ACTIVITIES

Stephen Marcus*

ABSTRACT

Much attention has been paid to design criteria for the computer interface. This presentation concentrates, instead, on the "innerface." The focus is on elements of instructional design that help make software intrinsically motivating for students at all grade levels. Generic examples will be provided of word processing files that help develop students' expertise with any given word processor and at the same time engage them in writing and language arts problem-solving activities.

An obvious application of word processing in the classroom is for the teacher to store a writing assignment on a disk. A student can then load the assignment as a text file, read it from the screen, and follow directions contained in the file that direct the student in a guided manner to add text to the file in order to produce a draft of a piece of writing. The student can retain r-levant parts of the instructions and writing "prompts" and print the resulting composition. The student's "new" file can be saved under a different name, leaving the original "template" available for someone else to use or, with certain kinds of templates, for the same student to use with a new topic.

There are features of the word processing environment that make the design of such templates -- intended for reading from the screen -- different from traditional, printed, worksheets, and the lessons learned from viewdata and teletxt applications are quite applicable here, i.e., those involving screen margins, placement of text, use of upper and lower case, color, fewer "ideas" per screen page, etc. There are, in addition, ways to design screen-based instructions in a word processing file so that the students can quickly flip through the screen pages without having to scroll the text.

These interface issues, while important, should not obscure the equally important issue of the "innerface," the qualities of the activity itself that help evoke from the student the intrinsic desire to become involved.

To begin with, there is suggestive evidence that word processors are akin to slot machines and videogames. People often seem to want to "play" a word processor because it is, in John Gould's phrase, a "real-time gadget with feedback." People -- even those for whom the novelty of the technology has long worn off -- will continue to tinker with their text, long after they've stopped improving the quality of their writing. There

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seem to be intriguing consequences of having your words, not carved in stone but written in light.

In addition, research by Malone and Leper on what makes videogames fun can be applied to the design of instructional activities that develop students' expertise in using the software itself as well as their skills as writers. This presentationillustrates several kinds of word processing activities that address both these goals, within a more broadly conceived orientation such as Arthur C. Clarke's, that "any sufficiently advanced technology is indistinguishable from magic."

INTEGRATING COMPUTER EDUCATION WITH THE TRADITIONAL PUBLIC SCHOOL CURRICULUM

Robert C. Tart, Jr.*

ABSTRACT

A model for implementing computer education in the public schools was developed. Integrating computer competencies with the curriculum was given emphasis rather than separate classes, particularly in the K-8 grades. The model addresses philosophy, curriculum, teacher training, acquisition of technology, and accountability issues. The implementation has been effective and efficient in providing students with the computer skills necessary to meet the defined educational goals.

INTRODUCTION

Duplin County Schools, located in rural eastern North Carolina, has 8,030 students in grades K-12. There are 16 schools in the district, served by 450 state certified educators and 350 other personnel. Initially, the district began to respond to the need for computer instruction on a departmental basis. Vocational, math, and science departments began including computer competencies independently. It soon became evident that a more coordinated district-wide approach would be needed in order to most effectively and efficiently prepare students for post-secondary experiences. The response to this concern was the Duplin County Schools' Computer Education Plan. The major components and results of the plan are presented below.

PHILOSOPHY AND CURRICULUM

The philosophy of computer education was defined as follows:

> It is the belief of the Duplin County Board of Education that youth preparing for entry into post-secondary institutions or the work force need to be able to interact with computers on varying levels. The level of interaction needed varies according to the individual's educational and career aspirations.
>
> Therefore, all Duplin County School's students will be afforded the oppportunity to become computer literate (as defined in the Duplin County School's Computer Education Plan) by the end of the eighth grade year and the opportunity to receive specialized computer instruction at the secondary level when required in light of the student's educational and career aspirations.

This philosophy guided the development of curriculum, selection of hardware and software, and the allocation of funds. The definition of computer literacy provided additional direction.

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Computer literacy for students in the Duplin County Schools will require competencies in the following areas:

(1) operation of the microcomputer
(2) care of hardware and software
(3) ability to select appropriate software to accomplish a task or to use software as a tool in problem solving
(4) brief historical development of computers
(5) uses of the computer
(6) computer-related jobs
(7) legal and ethical implications of computer use

The curriculum had to be developed with economy in mind, it had to insure computer literacy, it could not substantially take away time from existing content areas, it had to be efficient as well as effective. The North Carolina Department of Public Instruction's State Plan for Computer Utilization in the North Carolina Public Schools (ref 1) had to be incorporated. The curriculum organization pattern that evolved resulted in emphasis on computer awareness in Grades K-5, computer exploration in Grades 6-8, and computer specializtion in Grades 9-12.

The computer curriculum committee identified the competencies that should be included in computer education and also identified specialized courses that might be taught. These were selected from the North Carolina Standard Course of Study (ref 2), North Carolina Program of Studies (ref 3), Computer Education Competencies (ref 4) and other available listings. The identified competencies were then placed at grade levels based on level of difficulty and the skills the students should already possess in order to successfully complete the computer competency.

Once grade levels were established, the K-8 competencies were assigned to existing subject areas. One example is the inclusion of computer-related career information in the career exploration program in grades 7-8. Another is the integration of start-up procedures for the computer with teaching K-1 students to follow directions. The competency listing informs teachers about the "what, when, and where" to teach computer competencies.

Integration is emphasized at the secondary level. Teachers are encouraged to use computer applications and/or problem-solving methods whenever the content permits. Secondary students are also given the option of selecting courses that are more specialized in computer use. Generally the sequence offered is (1) Typewriting and Keyboarding, (2) Introduction to Computers, and (3) Computer Languages. The introductory course is broad based and introduces the student to programming in BASIC. Few students elect to take the languages course. Computers are integral components of courses in accounting, office practices, industrial arts, math, and science.

ACCOUNTABILITY

Students' progress is assessed in Grade 6 for computer literacy. Deficiences are addressed so that students may meet the standards prior to entrance into secondary schools. A second evaluation is completed at the end of the eighth grade.

As a motivational device and a method of accountability, licenses are issued to students. There are two levels. Level I is issued when the student demonstrates the ability to operate microcomputer hardware without supervision. Level II is issued when the student has demonstrated competence as defined by the district's definition of computer literacy. The evaluation for each level is accomplished by the student's demonstration of minimum skills and his successful completion of a written examination.

TEACHER TRAINING

A program was developed to give teachers the minimum computer competencies required to assist students in becoming computer literate. One teacher was selected from each school to serve as a teacher-trainer. The trainers were brought together for workshops with a package developed by the district to meet the requirements of the program. The training included sessions on (1) The Computer Education Plan, (2) Terminology and Operations, (3) History and Development, (4) Hands-On Training for the Hardware, (5) How to Integrate Computers with the Regular Curriculum, (6) Uses of the Computer, (7) Software Use and Selection, (8) Ethics, and (9) How to Train Other Teachers.

The trainers returned to their schools and presented the inservice which included a variety of video, lecture, and hands-on experiences. All teachers completed the training within two years.

ACQUISITION OF TECHNOLOGY

A computer committee was appointed and trained for the task of making recommendations for the purchase of hardware and software that would most efficiently and effectively meet the districts' needs. The curriculum, available resources, number of schools, vendor support, and maintenance were major concerns. Vendors were invited to demonstrate their hardware to the committee, make proposals based on the districts' plan, and respond to any concerns of the committee.

The committee's recommendation included two computer labs in each secondary school and mobile individual units (number based on student membership) for each school's media center. The district-wide approach has resulted in a student per computer ratio change from 150 in 1980 to 15 in 1987. The lowest ratio for an individual school is 9.6, the highest is 32.

RESULTS

The immediate positive results are that (1) all teachers have received initial computer training, (2) a support group made up of at least one teacher-trainer from each school has evolved, (3) computer hardware and software have been made available to students and educators, (4) computer education objectives can be achieved with a minimum of additional time and personnel resources, (5) accountability can be provided, and (6) an internal maintenance program has evolved.

Areas that require attention are (1) training of new teachers, (2) renewal inservice to maintain and update teacher competence, (3) evaluation to determine ways the curriculum may be strengthened, (4) defining new teaching methods which incorporate computer applications with traditional subject content, and (5) keeping abreast of the technology as it develops, particularly in the specialized courses at the secondary level.

REFERENCES

1. North Carolina Department of Public Instruction, State Plan for Computer Utilization in the North Carolina Public Schools. Raleigh, North Carolina 27603-1712.

2. North Carolina Department of Public Instruction, Standard Course of Study, Raleigh, North Carolina 27603-1712.

3. North Carolina Department of Public Instruction, Standard Course of Study, Raleigh, North Carolina 27603-1712.

4. Duplin County Public Schools, Computer Education Competencies (1983), Kenansville, North Carolina 28349-0128.

A STUDY OF FOUR STYLES OF LESSON AIDED BY A COMPUTER

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ABSTRACT

From extensive classroom observation, it is clear that there are a great many ways of using microcomputers in a lesson. But there are still a number of patterns of use which seems to recur. Lessons which are quite different in content, in ability level, and in the software that is used, may still have a similar kind of structure. Four lesson structures are described which have been observed frequently and which seem to make effective use of the computer resource as well as integrating well into other classroom activities.

INTRODUCTION

Lessons are the living reality of computer assisted learning. They are the culmination of a complex development involving the formulation of ideas, writing and revising software, bringing together ideas, some classroom observation and finally publication. But lessons are not the end of the process. Software often continues to grow even after it is published. The variety of different lessons that can be taught with the same piece of software is often not appreciated, except by someone who has been lucky enough to watch several different teachers working on the same program.

As part of a number of research and development studies, Investigations on Teaching with Microcomputers as an Aid (ITMA) has observed many hundreds of lessons supported by a microcomputer (refs 1 - 3). These have included a number of subject areas in both primary and secondary English schools. We have gone to some trouble to sample a good cross section of schools and of teaching styles.

Although there are a great many ways of using microcomputers in a lesson, there are still a number of patterns of use which seems to recur. Lessons which are quite different in content, in ability level, and in the software that is used, may still have a similar kind of structure.

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Here are four lesson structures which have been observed frequently and which seem to make effective use of the computer resource as well as integrating well into other classroom activities:-

- The explore-create-explore lesson
- The problem-posing and problem-solving lesson
- The do-reflect lesson
- The explore at the computer-explore away from the computer lesson

EXPLORE - CREATE - EXPLORE

The explore-create-explore lesson begins with pupils exploring an environment on the computer. In the next stage of the lesson, pupils create a similar environment of their own, either on or off the machine. The lesson ends by pupils exploring environments created by other pupils.

'Exploring an environment' can mean a great range of activities including interrogating a database, doing an investigation, exploring a simulation, and playing a strategic game. 'Creating an environment' could mean making your own database, modelling, designing your own game, making a picture, or writing a story.

The initial exploration of the lesson can take many forms, but this is usually a group activity around a computer. The group may be as large as a whole class with the teacher as part of the group.

The creative stage of the lesson will sometimes take place away from the computer. Or it may involve some planning away from the computer, followed by work at the computer. Both group and individual work can be successful here.

Although the final stage is often quite a short part of the lesson, it is an important one. Pupils should have an opportunity to see, and preferably to use the products of each others' creation.

PROBLEM-POSING AND PROBLEM-SOLVING

In the Problem-Posing and Problem-Solving Lesson, the elements commonly consist of exploring a computer environment, followed by, posing a problem, working towards a solution to the problem, and lastly some reporting or recording of what happened.

Not all of these elements may be present: for example, the problem-posing may be done by the teacher or the computer, rather than by the pupils.

This type of lesson often arises through the use of adventure games and through some types of programming including LOGO. Some educational software is designed to pose specific problems, while other software invites you to pose your own problem.

Teachers vary considerably in their approach to problem solving work. A key variable is how long a teacher is prepared to let pupils struggle at a problem before intervening with a hint or with their own solution.

Problem-posing and solving lessons tend to make quite heavy use of the computer, although some parts of the posing, solving and reporting activities can go on away from the machine.

DO - REFLECT

A fairly small number of lessons fall into the Do-Reflect category. The lesson consists of some kind of activity, followed by reflection on this activity, which involves some discussion and analysis by the class. The activity may involve role playing. The computer usually plays a part in both these stages.

EXPLORE AT THE COMPUTER - EXPLORE AWAY FROM THE COMPUTER

Finally, there is the "Explore at the Computer - Explore Away from the Computer" Lesson. There are quite a number of classroom activities which can be carried out both at the computer and away from the computer. This sometimes raises questions about whether it is cost effective to employ a computer for an activity which could be done without it. But this is not as simple an issue as it first seems, because transferring an activity onto the computer changes its character. By using a computer there are often changes in the low level cognitive demands placed on users. Roles that may normally be adopted by a human being are transferred to the machine. The computer speeds some things up but it demands a formality when communicating with which will often require different methods for decision making. There are a number of classroom activities which are worth trying both on and off the computer.

OVERVIEW

These four types of lesson are some which have stood out vividly among many we have watched. Some lessons could be placed in more than one category, for example, it is a fine point where problem-posing and solving ends, and creativity begins. Some types of lesson simply do not fit: there is no doubt that some pupils enjoy work at the computer which involves repetitive testing of factual information, but this does not fall comfortably into any of these categories.

One common element among the four types of lessons is that all allow pupils considerable scope for personal expression, but the form of this personal expression varies significantly among these four types.

REFERENCES

1. Petty, J., Burkhardt, H., Fraser, R. and Stewart, J. (1984). Micros in the primary curriculum: the ITMA approach. Pp 189-195. In Smith, P.R. (ed) CAL 83: Selected proceedings from the computer assisted learning 83 symposium. Oxford: Pergamon.

2. Phillips, R.J., Burkhardt, H., Coupland, J., Fraser, R. and Ridgway, J. (1984). The future of the microcomputer as a classroom teaching aid: an empirical approach to crystal gazing. Pp 173-177. In Smith, P.R. (ed) CAL 83: Selected proceedings from the computer assisted learning 83 symposium. Oxford: Pergamon.

3. Phillips, R.J. (1986). A microcomputer in every mathematics classroom. In Button, N. (ed) Exploring mathematics with microcomputers. London: CET.

MANAGING COMPUTER OPERATIONS FOR AN EDUCATIONAL ENVIRONMENT

J.B. Palmer*

ABSTRACT

Computer operations at the Fort Knox Community Schools involve administrative and instructional environments. The school district's philosophy enables a one-to-one student-computer ratio and from one-to-three hours of weekly computing for each of its 4,000 students. The computer systems comprise approximately 800 microcomputers of different brands and operating systems in both stand-alone and network configurations. Over 2,000 software packages are used, including keyboarding, word processing, spreadsheet, database, computer-assisted instruction, computer-assisted design, attendance, accounting, inventory, library, and cafeteria. The district's computer systems are managed by the Department of Computer Media. Its responsibilities include consultation, selection, design, evaluation, installation, maintenance, conversion, training, customizing, and support. Management problems include keeping pace with technological advancements, scheduling nontechnical job responsibilities, and acquiring sufficient communication lines. Future computing plans include electronic mail and bulletin boards, desk-top publishing, and cafeteria and theater management programs.

INTRODUCTION

The Fort Knox Community Schools District is a U.S. Department of Defense public school system located on the Fort Knox U.S. Army Post. Its 4,000 student enrollment in Grades K-12 are children of active-duty military personnel living on Post. Physical facilities include several administrative offices and ten schools (one secondary, two middle, and seven elementary). The Fort Knox Community School District's philosophy includes the development of a curriculum integrated with computer instruction.

The district's commitment to computer education is reflected by the maintenance of its one-to-one student-computer ratio with every student receiving from one-to-three hours of weekly computer instruction. In addition, a Department of Computer Media operates at the central office level to manage the district's administrative and instructional computing needs.

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EDUCATIONAL COMPUTER SYSTEMS

Several computer systems are required to meet the administrative and instructional needs of the Fort Knox Community Schools District. All of its systems, however, are microcomputer based. This type of hardware was selected because of budgetary restrictions but also for reasons of flexibility, ease of operation, and computing capabilities.

A variety of computer systems co-exists to serve the district's administrative needs. Newer installations include Tandy and Zenith microcomputers with MS-DOS and Xenix operating systems. Some microcomputers are stand-alones and others are in 3-COM or Xenix networks. These systems are replacing the WANG OIS series and Radio Shack computers. Administrative software includes word processing, spreadsheet, database, and statistical applications as well as attendance, accounting, inventory, and cafeteria packages.

The instructional computing systems include a large base of Radio Shack and Apple microcomputers. A gradual phase in of Tandy MS-DOS microcomputers has begun in the secondary schools. Although many individual classrooms have stand-alone microcomputers installed, the bulk of instructional computing is done in laboratories located in each school. These laboratories are equipped with up to thirty-two networked microcomputers and staffed with a full-time aide. The aides operate the equipment, maintain the software libraries, and provide faculty with lists and recommendations of software to accompany classroom activities.

Each school has its own library. The libraries access a local area network using a central host, and each site has three to five microcomputers. Library circulation is accomplished with a bar code optical scanner, and software is used to keep records of library acquisitions of books, artifacts, and audio-visual materials. Reports are generated on the status of the libraries on a daily, monthly, and yearly basis.

The district owns over 2,000 software packages for instructional use. A wide variety of computer-assisted instruction (CAI) exists for every school subject, including computer-assisted design (CAD) for drafting classes. Of special interest is the district's computer-integrated language arts curriculum. Students receive keyboarding instruction in the first grade and continue with word processing instruction in the second grade as a means of developing composition skills. At the middle school level, computer instruction is offered in the "mini course" mode and in accordance with the instructional needs of the classroom teachers. At the secondary school level, the curriculum includes courses in computer literacy, word processing, and programming in BASIC and PASCAL.

COMPUTER SYSTEM MANAGEMENT

The Department of Computer Media is responsible for management of the district's administrative and instructional computer systems. The Department consists of a full-time director who supervises a staff consisting of a programmer/analyst, educational specialist, electronic technician, floating keyboarding/word processing instructor, and twelve computer aides. The responsibilities of the Department involve consultation, selection, design, evaluation, installation, maintenance, conversion, customizing, backup, training, and support.

Several problems accompany management of the district's computer systems. The chief problem is attempting to keep pace with the advancements in technology for adaptation to the district's needs. Another problem involves the scheduling of nontechnical job responsibilities into an already full schedule of technical requirements. The third problem is difficulty in acquiring sufficient telephone lines to support the district's need for electronic communication.

The computing needs of the Fort Knox Community Schools District are expected to continue to expand. Future plans include implementation of electronic mail and bulletin boards as soon as technical and monetary restrictions allow. New cafeteria management software is scheduled for implementation shortly. This software will provide point-of-sale information with charge back to each student's account, capability to check the dietary requirements of each sale, and inventory control. The newest computer system under investigation is for theater management. The requirements for this need involve accounting, box office, and lighting design.

EDUCATIONAL TECHNOLOGY IN THE URBAN CLASSROOM

A. V. Houston*

ABSTRACT

In this age of technological advances it is becoming increasingly important for educators to provide students with a realistic view of the world. With the depletion of funding available to urban public schools this is not an easy task. Seattle Public Schools is attempting to meet the challenge of ensuring that all students are computer literate prior to graduation. This is done through existing programs and the piloting of new programs with the assistance of a variety of departmental technological support services.

Technical competence is critical to the success of all students as they enter the 21st century. Traditionally, urban schools have not kept pace with their suburban counterparts in the technical areas. As a result urban students, who are frequently economically disadvantaged by birth, are also disadvantaged by the lack of technical education necessary to succeed in the work world. The urban staff of Seattle, Washington is making significant progress toward reversing that trend and is providing a technical skill base which allows urban students a competitive edge.

Seattle Public Schools enriches and maximizes each students' experience with the use of technology. Integrating computers and other educational technologies into the educative process assures a comprehensive understanding of the real world. In an urban setting with less than adequate public school funding and fiscal problems, the question becomes how to not only keep pace but also move ahead. Despite fiscal constraints, Seattle Public Schools recognized this challenge and in 1983 adopted a goal to ensure that all students are computer literate prior to graduation. Some of these needs have been met through the creative use of general district funds, augmented by federal and state categorical funds.

Computer education begins at the elementary level. Students at this level are expected to acquire: (1) knowledge of a computer as a machine that follows instructions; (2) awareness of common, current uses of computers; (3) understanding of the importance of giving and following clear directions; (4) ability to load programs into a computer and run those programs; (5) capacity to develop a series of commands that cause a computer to carry out a specific task; and, (6) familiarity with the keyboard. Students are also given experiences in computer-assisted instruction (ref 1).

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The secondary level expands this knowledge base by providing computer literacy experiences and by offering instruction through advanced programming. Fundamental skills on the secondary level include the following: (1) vocabulary; (2) care and operation of hardware and software; and (3) keyboarding. These fundamental skills are used in a variety of applications to integrate knowledge of computers efficiently. The process involves: software programs; computer arts; word processing; content area software uses; data bases; telecommunications; spreadsheets; and interfacing. The computer is also used to prepare students in the area of ethical and social issues by exploring laws and the implications and standards associated with the age of technology. Computer usage at the secondary level also offers advanced skills in problem analysis and solution design; programming languages, structure, and syntax; error correction and testing of results; programming style; and documentation (ref 2).

Seattle teachers believe that the increasing impact of technology makes it essential to implement a program which develops technological literacy. Recommended computer activities were developed based on the concept that computer education should be acquired at a level comparable with other fields of study (ref 3). Additional methods of integrating technology into urban students' educational experiences are being tested. Among them are the following pilot programs:

- Education Systems Computer Laboratories are a system of computer-assisted instruction which includes reading and mathematics curriculum. The program emphasizes basic skills reinforcement as well as stressing critical thinking and problem solving for all students at all levels of ability. With the assistance of a trained computer laboratory attendant, students' questions are answered, activities are monitored and performance reports are provided.

- The Video Encyclopedia, with extensive documentary film, permits students and faculty to research almost any major event in the 20th century and view the actual film footage. It allows not only the opportunity to interpret but also enables compilation of various historical events and the creation of educational films tailored to meet individual unit objectives. These videos then become part of the school's audio-visual collection. This technology is an extremely powerful motivational and instructional device.

- Satellite Telecommunications programming enhances the district's ability to equalize educational opportunitites and offer advanced and specialized courses that would not otherwise be available to students. Staff development via satellite provides local, cost-effective opportunities to help teachers meet increasing professional development needs.

- The Integrated Writing to Read Program is a computer-based writing and reading system for kindergarten and first graders. It is based on 42 phonemic sounds taught in ten cycles, with approximately three sounds a cycle. By the completion of first grade, many students in the program are able to read anything they can write and write anything they can say.

- Interactive Video Laser Learning is a complete system for ensuring mastery of the key reading skills. In addition to disc lessons, the program offers a full range of content related materials supporting the lessons. These materials include tests, related reading, computer-assisted instruction, and homework activities.

Furthermore, various departments provide technological support to the schools. The following are a few examples of this support.

- Compensatory Education is a program subsidized at both the state and national levels. It is aimed at increasing the achievement of low-achieving students. Compensatory Education makes use of computer-assisted programming. The Prescription Learning Computer Assisted Instruction Laboratories offer diagnostic testing for curriculum placement, prescriptions for the remediation of identified weaknesses and a management system for the purpose of diagnosing, prescribing and recording data on each student.

  As stated by Slavin (ref 4), intensive supplementary models which include computer-assisted instruction are one of the major categories of effective Compensatory Education programs. This technological addition to the Compensatory Education program appears to be extremely valuable, offering motivation and reinforcement and providing students with an alternative learning style.

  Most of the youngsters come from low-socioeconomic backgrounds and would not have this technology available in their homes. The in-lab service is extended to the home of these students on a rotating basis with the use of the Take Home Computer Program. Parents and other siblings in the family are also trained in the use of the computers.

- The Science/Technology Teacher Specialists work with classroom teachers and students to promote the integration of a technological curriculum into all subject areas. Among the desired goals is that students gain technical knowledge and develop rational, creative, critical thinking skills and attitudes that will enable them to solve problems so that they can live more competently in a world impacted by accelerating change.

- Major efforts have been made in the Special Education Department to utilize computer technology to complement a number of legally and educationally mandated tasks. Included are specialized computer-assisted instruction for handicapped students and computerized individualized education programs for each student. With the use of technology the centralization of forms, confidential files and data for maintaining, tracking and analyzing these components are readily available.

- As a result of a Title VII Computer Assisted Instruction Grant computers were made available to the Bilingual Office. Through this grant the Bilingual Office developed software, in Cambodian, Spanish, Vietnamese, and Laotian, in U.S. History. These curriculum materials are being used at the high school level.

- New computer technology is integrated into the Vocational Education Program. A statewide curriculum task force is assisting Seattle Public Schools on an ongoing basis with a comprehensive, articulated curriculum for micro-computers in vocational education.

  Jeff Bush (ref 5), writing about moving today's technology into schools, speaks about the Vocational Education curriculum as being oblidged to expose students to current concepts in industrial technology. He believes that through the stimulation of students minds comes the inspiration and ideas for the technology of tomorrow.

Many teachers, based upon interest, use computers in novel ways. This usage ranges from primary Physical Education Specialist Keith Semler, who developed his own physical activities management and evaluation system using "pfs" software, to secondary teacher Patsy Ethridge and her use of Comp-U-Serve and Collier Encyclopedia to have students research information for their various classes.

In conclusion, to be future oriented computers and other educational technologies must be integrated into the educative process. This is crucial in developing strategic critical thinking, problem solving and decision making skills in students. By making use of these skills and cognitive theories, the urban student will be better prepared to meet the demands of an ever changing world.

1. Seattle Public Schools, Elementary Computer Activities, iii(1983)

2. Office of the Superintendent of Public Instruction, Washington State, Washington State K-12 Computer Education Curriculum Guidelines, 5(1986)

3. Seattle Public Schools, Elementary Computer Activities, ii(1983)

4. R.E.Slavin, Phi Delta Kappan 69 2, 110(1987)

5. J. Bush, GCT 10 3, 26(1987)

COMPUTERS AND EDUCATIONAL ADMINISTRATION - MANAGING INFORMATION TO IMPROVE THE QUALITY OF EDUCATION

J.B. Baxter*, J.E.Bruno**

ABSTRACT

Modified Confidence Weighted-Admissible Probability Measurement (MCW-APM) is a recently developed computer based confidence type test scoring procedure that, when used with multiple choice testing, is designed to provide a more comprehensive and precise information referenced assessment of the knowledge base of the student. This assessment can then be used to generate information useful to students, teachers, and school administrators in their efforts to improve instructional quality.

This study reports the results of preliminary research carried out in a large urban school district that utilized computer technology coupled with the MCW-APM information reference test (IRT) scoring procedures to generate an information base directed at improving the quality of instruction.

INTRODUCTION

The use of computers in instruction is rapidly coming to be commonplace in American public education. An ancillary benefit of the use of computer technology in education is that it can be used to significantly enhance the quality upon which to make classroom, school site, and school district decisions concerning instruction. This study reports the results of research carried out in a large urban school district that utilized computer technology coupled with an information referenced test (IRT) scoring procedure (MCW-APM) to support an information system designed to improve the quality of education.

OUTLINE OF THE MCW-APM INSTRUMENT AND SCORING SYSTEM

MCW-APM is a test scoring procedure that, when used with a multiple choice testing format, is designed to enhance the classroom formative evaluation process and, more importantly, generate reliable information upon which to base instructional decision making thus improving the quality of instruction. For a student taking a test with MCW-APM, confidence in one of three choices to a test item is spatially represented on a response triangle. Each vertex

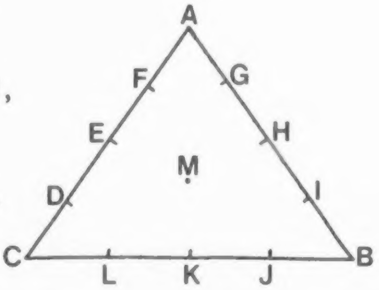

Figure One
The Response Triangle

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of the triangle represents (to the student) 100% confidence in one of the three choices associated with the test item. Three intermediate points, located on each of the three sides of the triangle, represent partial confidence or .25, .50, .75 probability or confidence between two respective choices. One point located at the exact center of the triangle represents equal probabilities or confidence (A = .33, B = .33, C = .33) among the three choices (see Figure One). The point awards associated with the various levels of confidence in an answer is specifically designed to insure congruence between the conforming strategy of the test developer and the point maximizing strategy of the student. The main objective of MCW-APM is to minimize distortions in test scores introduced by the need of students are free to answer test maximize their score. With MCW-APM, students are free to answer test items in less restrictive response environments by using various MCW-APM letter options that indicate "I know," "I don't know," or "I am not sure."

The MCW-APM test scoring procedure references student attainment to an information based standard of mastery which varies on a continuum from being fully informed (100% confident and correct) to fully misinformed (100% confident and incorrect). Multiple choice testing thus becomes the more comprehensive and precise information referenced testing (IRT) when using MCW-APM type scoring. The information resulting from IRT assessments can then be used by teachers and school officials to conduct instructional audits, training audits, curriculum articulation, curriculum design, evaluation of instruction and the design of cooperative or paired learning programs.

The MCW-APM procedure is fully computerized and has optical scan capabilities. The computer analysis generates the following management information that can significantly enhance the quality of education by directing attention at weaknesses in the instructional program. First, individual education plans (IEPs) for each student (indicating, with instructional cross-references, specific areas of information, misinformation, lack of information, and partial information in a student information base), (2) a detailed analysis of the instructional program (identifying common areas of information, misinformation, lack of information, and partial information), information referenced classroom student assessment (a detailed analysis and breakdown of the type of information possessed by each student in the class), (4) recommendation for paired learning or cooperative learning assignments based upon an information referenced standard, and (5) a detailed item response analysis of the assessment instrument itself that is designed to find those test items and responses that contain large amounts of uncertainty and are favored by students taking the examination. This latter analysis can be used to redesign the assessment instrument itself. Thus, the IRT analysis produces valuable management information for students, teachers and program evaluators.

THE URBAN CITY RESEARCH

The MCW-APM test scoring procedure was used to assist with the designing of an mathematics program for 250 fifth and sixth grade students in a large urban area of California. These students attended schools which over the years and as an average had the lowest achievement test scores in mathematics in the city. The evaluation of these students' mathematical abilities with the MCW-APM test scoring procedure was used to provide a clearer picture of the academic strengths and weaknesses of each student. The IRT procedure, unlike R-W procedures for multiple choice tests, awards partial credit for partial information. Students were also free to admit lack of knowledge without incurring any penalties thus eliminating their need to guess. Examining data across the various information states resulted in teachers and administrators designing an instructional delivery system that would address the actual information deficiencies (misinformed, uninformed, partially informed) in the student's knowledge base.

The teachers then analyzed the strengths and weaknesses of their instructional delivery across the test items using a detailed IRT item analysis. This analysis identified common areas of information, misinformation, partial information and lack of information across students in their classrooms (see table one). Note that for item 4 there is a high percentage of students who are misinformed. This indicates the need for a careful analysis as to the reasons why so many of the students are confident in the wrong answer for this test item. The instructional signal (teaching plus materials) as received by the student in the classroom may not be what is intended, but be distorted, weak, or even non-existant.

Information Referenced Analysis of Instructional Signal

Item	Description	Inf.	Part Inf.	Uninf.	Misinf.
1	MC57 Add Whole Numbers Holt 5/38-39	22.00	0.00	0.00	3.00
2	MC57 Add Whole Numbers Holt 5/38-39	21.00	0.00	3.00	1.00
3	MC59 Subtract Whole Numbers Holt 5/52-55, 88-89	23.00	0.00	1.00	1.00
4	MC59 Subtract Whole Numbers	15.00	0.00	0.00	10.00

(etc. until all test items have been printed)

Most Misinformed Items for Class

Item	Percent of Class	Item Description
22	0.56	MCA68 Numeration - Holt 5/2-7, 9
28	0.48	MCA68 Numeration - Holt 5/2-7
32	0.48	MCA71 Problem Solving - Holt 5/64-65
4	0.40	MC59 Subtract Whole Numbers - Holt 5/52-55

(etc. until all test items have been ranked by information state)

Table One - Instructional Signal Delivery Analysis

Recommendations were then made, based on the information states demonstrated by the students, for cooperative learning assignments for each classroom. By pairing students with reliable information with those students with less reliable information teachers were able to simultaneously coordinate the remediation of many students. This permitted a cost efficient, tightly structured, highly individualized instructional delivery system within a classroom context and thus enhanced learning.

The school site administrator used the detailed analysis of the instructional program as delivered by the teachers across grade levels to suggest professional collaborative instructional efforts. Teachers were thus placed in positions of peer supervision and peer coaching directed towards the overall improvement of instruction. The strengths of one teacher could be utilized to support the possibly weaker instructional delivery of another teacher. This process could provide a strong sense of professionalism and a bonding to the instructional program among the teachers. Each teacher would then be able to function as an "expert" on different aspects of the tested skill areas of the instructional program.

The school administration and supervisory personnel meeting with teachers at each grade level could also analyze the skill areas of the test that were deficient in order to determine what additional instructional support could be provided to the teachers and students. This support could take the form of new curriculum materials, better distribution of students of varying academic abilities to their classroom assignments and more appropriate use of time-on-task activities for maximizing the efficiency of instructional time allocated to mathematics.

Similarly district administrators might also be interested in the delivery of the instructional program and the utilization of funds, materials, and time allocations for the mathematics program. Deficiencies in the instructional program were highlighted in the IRT analysis and recommendations made for providing central office support and expertise to the local school site. In-service classes and workshops were then designed to specifically assist the teachers in improving the quality of their instructional program.

THE CONCLUSIONS OF THE STUDY

The results of this research indicate that the notion of designing and managing classroom instruction according to levels of reliable information in a student knowledge base is an important element that is usually missing with information based on R-W test scoring. The quality of the instructional program can be significantly improved by the appropriate use of this information by teachers and administrative personnel. Computer technology and IRT type test scoring procedures can be a valuable asset to school efforts at improving the quality of education through the redesign of its instructional program to accommodate the actual informational needs of students.

UNDERSTANDING AND CONCEPT ACQUISITION IN ADAPTIVE INTELLIGENT TUTORING SYSTEMS

B.M. Cox†, J.Jenkins† and E.Pollitzer†.

ABSTRACT

Intelligent tutoring systems (ITS) developed to-date have, by and large, focused on the in-depth analysis of the task to be performed. Little emphasis has been placed on the conceptual framework necessary for understanding that task. The view put forward in this paper is that acquisition and a proper understanding of the framework of concepts referenced by the task is a prerequisite step in effective problem solving.

EXPLANATION-DRIVEN UNDERSTANDING-DIRECTED LEARNING

A notion of explanation-driven understanding-directed (EDUD) learning is introduced. In the EDUD tutoring program, understanding is achieved by the development and re-structuring of 'cognitive structures' using appropriate explanation facilities. The goal is to obtain a hierarchically organized set of functionally related information structures relevant to a particular problem domain. There are several stages of transformation through which the relative cognitive structures must pass before an understanding of the subject can be claimed. It is held, that the order in which these stages is traversed is sequential (ref 1).

Each stage, therefore, represents an essential level in the hierarchical structure aimed at. The criterion behind this is simple namely, the user cannot understand stage x before he understands stage y (ref 2). Such a hierarchical goal structure has particular benefits for tutoring purposes and system design. Once the level of understanding at which the user is functioning is identified, the system can offer the necessary explanations which will drive him to the next level in the hierarchy.

THE DEVELOPMENTAL STAGES

The EDUD approach identifies the following stages of understanding through which the individual passes in the problem solving process (See Figure 1). Each stage is identified with a particular abstract, domain-independent or domain-dependent rule.

1. The Stage of Figurative Knowing
2. The Functional Stage
3. The Cause/Effect Stage
4. The Complex Derivational Stage
5. The Stage of Hypothetico-Deductive Reasoning

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STAGE 1. The Stage of Figurative Knowing

The first abstract rule to be applied in stage 1 of the understanding process is to 'discover the definitional attributes of a particular concept'.

The goal of the explanation in this stage is to ensure that the user understands the basic definitional characteristics and attributes of a concept in a specific domain together with their value. He is encouraged to have an intuitive grasp of the 'surface' characteristics of a concept. Unless figurative knowing can be 'fixed' the user will be unable to understand relationships at higher levels in the hierarchy. An effective method of providing 'meaning' to a new concept is to encourage the user to classify this new information in the light of what he already knows for example by providing him with examples or analogous situations.

The explanation process is commonly initiated in this stage by questions such as 'what is...?', 'is it...?', 'how much is...?'and understanding-directed by 'it is..'.

It would not be possible, for example, for the user to understand what causes syzygy (i.e. to understand the causal stage) before the user has some understanding of what 'syzygy' (syzygy refers to the stage of the new moon) means (figurative knowing stage).

STAGE 2. The Functional Stage

The abstract domain indepedent rule in stage 2 is to 'discover the purpose or use of an object or action'.

An example of the goal in this stage is that functional relationships be understood. Attention should be paid in this stage to the difference between 'cause' and 'function which are not synonymous. Functionality differs from causality in its attention to goals. In many instances a functional relationship underlies a causal chain which consitutes a procedure.

The explanation question here is 'for what purpose?...' and the understanding directed by 'for the purpose of....'

The user may understand for example that the function of the starter motor is to start the car but in order to understand how this is done, he needs to progress to understanding the causal relationships in the next level.

STAGE 3. The Cause/Effect Stage

The abstract domain-rule to be applied in stage 3 is to 'discover causal relationships'.

The explanation aims to ensure that the pertinent cause/effect relationships between entities are understood. We distinguish between direct causal relationships i.e. where there is no ambiguity about the cause/effect link and relative causal relationships, where the entity represents an object which may have causal influence under particular conditions.

Explanation may be sought at this level by asking 'how.......?'and understanding directed by 'by.....'.

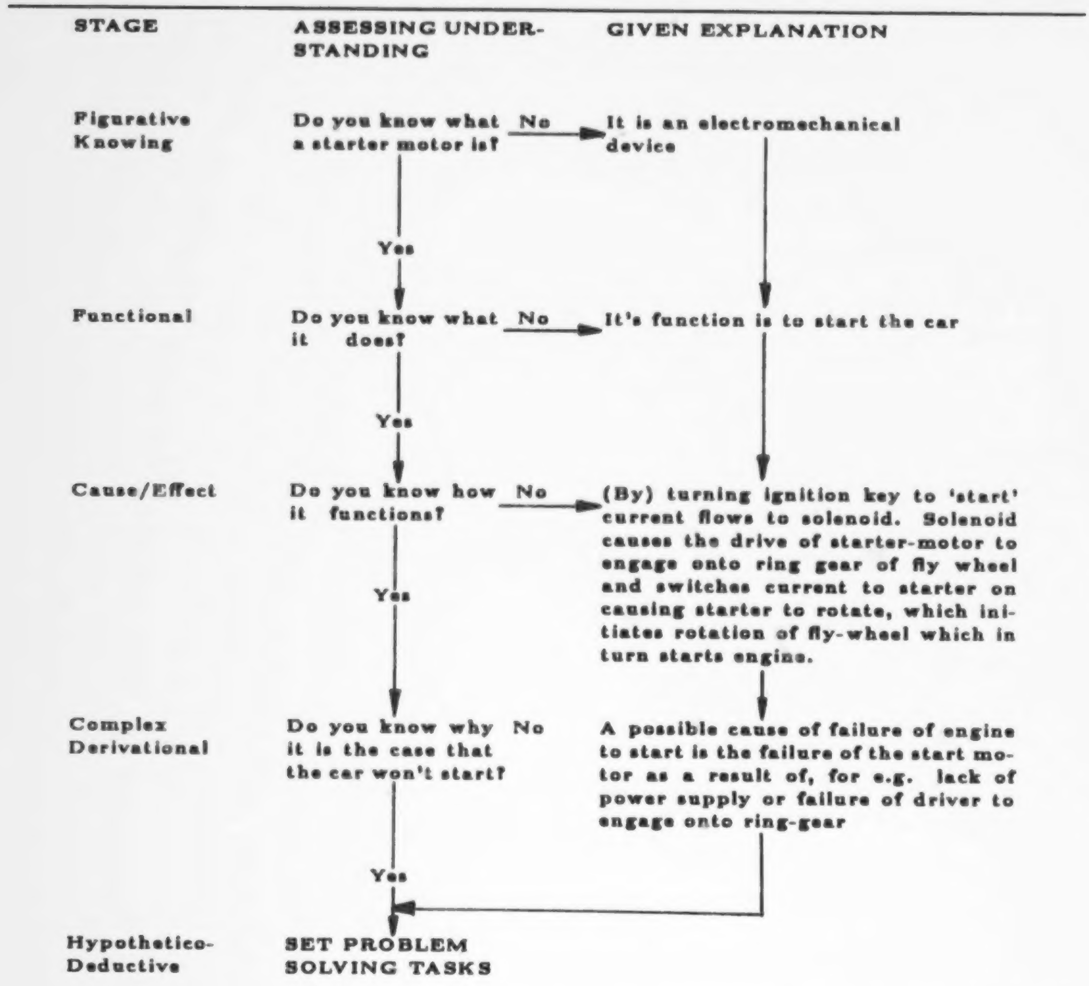
STAGE
ASSESSING UNDERSTANDING
GIVEN EXPLANATION
Figurative Knowing
Do you know what a starter motor is?
No
It is an electromechanical device
Yes
Functional
Do you know what it does?
No
It's function is to start the car
Yes
Cause/Effect
Do you know how it functions?
No
(By) turning ignition key to 'start' current flows to solenoid. Solenoid causes the drive of starter-motor to engage onto ring gear of fly wheel and switches current to starter on causing starter to rotate, which initiates rotation of fly-wheel which in turn starts engine.
Yes
Complex Derivational
Do you know why it is the case that the car won't start?
No
A possible cause of failure of engine to start is the failure of the start motor as a result of, for e.g. lack of power supply or failure of driver to engage onto ring-gear
Yes
Hypothetico-Deductive
SET PROBLEM SOLVING TASKS

Figure 1. An example of the EDUD teaching process

For example, if a user understands what a starter motor is (figurative knowing) he is then in a position to understand that its function is to start the car (functional stage) but in order to know how this is done, he needs to understand the underlying electro-mechanical relationships ('causal').

STAGE 4. The Complex Derivational Stage

The abstract domain-independent rule to be applied in this case is to 'discover why it is the case that.....'.

The goal of the explanation at this stage of the EDUD model is to ensure that given an effect the user may infer a cause. This is possible only if all the prior definitional, functional and causal relationships have been understood.

For example, to understand why it is the case that the car does not start, the first step might be to test for functionality, seeing if the starter motor is installed, then testing for causality by seeing if the starter motor works. Only after this is it possible to understand that, for argument's sake the reason why the car does not start is that the electrical supply to the starter motor has been interrupted. Such inference is impossible without understanding of the concepts involved.

STAGE 5. The Stage of Hypothetico-Deductive Reasoning.

In this stage the results of the prior phases of classification, seriation etc. are used as propositions which are then further operated on. That is to say, various kinds of logical connections are made between them (identification, disjunction, conjunction, implication etc.). In this stage the user applies his previously acquired information directly in a new situation.

In this stage various pieces of information are compared and explanation is often induced by the question 'what if....?' and understanding-directed by 'if......then'.

It might, for example, be germaine to ask what the effect on a starter motor would be were the car's battery to be removed for some reason?

The final stage is that which comprises expert reasoning. Here the expert uses both his theoretical knowledge of the domain (as learned in stages 1 to 5) together with his experiential knowledge to form heuristic solutions to problems. This form of knowledge may be acquired through an articulate expert system, a detailed account of which is not given here other than to point out that the same principles used in the first stage of the EDUD model may be applied to this expert system. For example, should a user ask a question, the system first establishes his level of understanding as a frame of reference and explanation is directed at this level.

CONCLUSION

We believe that the most realistic approach to intelligent tutoring systems is that they be based on a clear hierarchy of levels of understanding. We believe that problem solving skills are of subsidiary importance in tutoring because they are rarely domain-independent. Thus, the most productive tutoring systems are likely to be those which base themselves on an explicit theory of human information processing.

References

1. J H Flavell, The Developmental Psychology of Jean Piaget (Litton Educational Publishing, Inc., 1963) pp41–84

2. H Gardner, Developmental Psychology — An Introduction (Little, Brown & Company (Canada) Ltd., 1978) pp66–71

Acknowledgment

The Principal Author is supported by a Science and Engineering Research Council Grant

BREAD TODAY, JAM TOMORROW: THE IMPACT OF AI ON EDUCATION

Benedict du Boulay* and Aaron Sloman*

ABSTRACT

There are domain-specific and domain-neutral problems in designing ITS. The domain-neutral problems include: encyclopaedic knowledge, combining different kinds of knowledge, knowing how to devise a teaching strategy, knowing how to monitor and modify the strategy, knowing how to motivate intellectual curiosity, understanding the cognitive states and processes involved in needing (wanting) or an explanation, knowing how to cope with social and affective processes, various communicative skills (this includes some of the others), knowing how to use various representational and communicative media, and knowing *when* to use them (an example of strategy).

INTRODUCTION

Attempting to build intelligent teaching systems (ITS) has a large potential pay-off in the long term, both through practical systems produced and because of the theoretical developments in our understanding of teaching, learning and communicating that such systems would necessitate. However, good research in AI characteristically reveals problems that transform optimists into doubters, and there is at least as much reason for this to happen in the field of ITS as in work on vision, language understanding, learning and so on. Like many other A.I. systems, ITS tend to have a very narrow range of applicability, to degrade badly when working outside their sphere of competence, to be unable to combine different kinds of knowledge, and to lack the wit to know when they are attempting to teach beyond their means.

Some of the difficulty is domain specific: explicitly encoding human knowledge in any non-trivial domain is difficult. But many teaching issues cut across domains.

COMMUNICATION

The impoverished repertoire of teaching behaviours of most ITS (ref 1) might best be regarded as an impoverished understanding of communication in the wider sense. In limited cases a teacher can trade-off knowledge of communication against knowledge of the domain and detailed knowledge of the particular student being communicated with. Thus a human tutor can occasionally "teach" by offering a friendly ear to a student in difficulty so that in merely attempting to describe the problem the student solves it without any real help. In other cases a tutor can trigger independent discovery by asking a few leading questions. Such questions need to be chosen to suit both the problem and the student. How? Answering that requires a deep theory of learning, which can explain why certain ways of acquiring information produce more effective learning than others.

Several more kinds of communication used by any good teacher will have to be embodied in truly intelligent teaching systems. For example a good teacher will often get students to feel puzzled about something before presenting the explanation. How? Again an answer presupposes a theory: of the nature of intellectual puzzlement and the cognitive function of explanations - not to be found, for example, in standard text books on explanation in science. More generally we need to understand what makes someone *want* to know something. Not all intellectual curiosity is derived from specific practical goals. A good communicator exploits an intuitive understanding of how to make the listener want to know more. Why are we upset when we miss the ending of a story?

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It is easy to forget that teaching is a social behaviour that exploits both the teacher's ***and the student's*** rich human understanding of communication in general. Work is proceeding on unravelling some of the complexities of tutorial dialogues (see e.g. ref 2) but it does not approach a good human teacher's ability to take account of the social and affective aspects of personality with which teaching and learning are intimately bound up. This includes, for example, using cues like tone of voice and facial expression in determining what the real problems in learning are: noticing that the learner is upset may be more important than identifying the concept that has been misunderstood.

MODELLING GOALS AND BELIEFS

Even though ITS have moved beyond the "bucket" theory of knowledge transfer, they still tend to treat the student as an asocial, disembodied and disinterested seeker after truth or skill, able to communicate effectively through a very narrowly circumscribed set of formalisms.

There is no sense of such systems seeing themselves as part of some wider educational process with its own setting (including other teachers, other students, institutional goals etc), a setting within which the students have chosen to locate themselves with their own complex web of objectives, expectations and pre-conceptions about themselves, the setting, the subject domains and so on.

The student should be modelled as an affective being, with both intellectual and non-intellectual motives and capabilities playing a role in learning. The ITS should take into account the student's beliefs about his or her own knowledge or learning (which may be incorrect) and not just the knowledge of the domain itself: a student's mistaken belief that he understands something is a very effective barrier to learning.

It is important to identify correctly (and possibly adjust) the student's goals in relation to his learning. Learning something deeply can hard work and a student has to be motivated to expend the extra effort. Soloway reported at the Pittsburgh AI in Education Conference 1986 that he had to "bribe" students to learn more deeply by grading their work when he wanted them to produce and *critique multiple* solutions to a programming problem. Is the problem that we do not yet know how to stimulate intrinsic intellectual motivation, or is it inevitable that certain worthwhile forms of learning will not be found intrinsically worthwhile by students?

PRESENTATION

A good teacher communicates using media that are natural for the student, and the problem domain, including speech, diagrams, pictures, etc. The teacher must have the same understanding of these as the learner, and should be able to interpret speech or pictures produced by the learner, make sense of the learner's pointing gestures, etc. The difficulty is not simply an issue about lack of visual, tactile and aural input to the ITS or lack of spoken output. It is about making choices about how to present ideas in different ways for different purposes. Should a diagram be used by the ITS or will a sentential (ref 3,4) representation better facilitate the desired inferences? How? On what basis might such a decision be made? There is also the issue of allowing the student to communicate his or her understanding diagrammatically to the ITS. This needs no hardware revolution but it does need a much richer set of representations for the domain than is common. And, of course, giving computers a human like understanding of a variety of forms of representation is a hard AI task.

COMMON SENSE KNOWLEDGE AND TEACHING PROGRAMMING

Greaterp is one of the best current ITS for LISP programming (ref 5). It is able to take the novice through the first few hours of LISP and monitor and correct mistakes as they build simple programs. The system keeps very close tabs (perhaps too close) on what the student is doing, can recognise many standard errors and will try where possible to prevent the student from getting into a serious muddle.

But there are some things that humans can do that it is hard to see yet how to automate within a Greaterp-like framework. Some students require a fair amount of encouragement and emotional support to get to grips with programming and to put up with the many mistakes that naturally occur when one is learning such a complex many-faceted skill. The human teacher, in a sense, can become a confederate sympathising with the student in his or her struggle with the brute machine. It is not clear that the ITS itself could take on this supportive role.

An effective teacher needs to be able to identify the particular way the student understands or misunderstands a particular concept, technique or fact, in terms of that student's prior knowledge and concepts (as in Proust, ref 6). But students can misunderstand programming with all the richness of their existing knowledge, so identifying that a student has used the wrong model for some technical concept often requires highly creative insight, involving knowledge of diverse domains. It may not be possible to identify the misunderstanding at all only by reference to the student's problem-solving *within* the domain but may require some kind of conversation with the student at a higher level about the student's beliefs about the domain and its links to other domains.

There are also the difficulties of dealing with some of the other skills (besides program construction) involved in programming. Non trivial learning requires students to be creative about linking knowledge from the new domain with previously known domains. For many students, the more freedom they are given to choose which bridges to build, the more highly motivated they are likely to be, and therefore the more likely they are to be really engaged in the work, and as a result the more likely they are to acquire deep understanding. Why? Given such freedom human learners are liable to bring in knowledge about almost any topic they know about and thus an intelligent teaching system would need to have encyclopaedic knowledge and powers to grasp good and poor analogies between different domains.

The most dramatic learning phase in teaching our elementary programming and AI course at Sussex to absolute beginners (some with a non-scientific, non-mathematical, background) usually comes at the "project" stage, after 6 or 7 weeks of "bottom up" learning to use the editor, playing with demonstration programs, and learning a range of programming techniques mostly by imitation and instantiating program schemata. In the "top down" project phase they invent their own project, making use of the POP-11 (ref 7) pattern matcher and database package and other programming constructs. They work on the project for 2 to 3 weeks and submit a written report on it.

For many students, even if they have previously done many *tutor-directed* exercises, it is only when they do a project *they* have chosen, which requires them to evaluate, select and use concepts and techniques from among those studied during the previous weeks, that they really begin to understand and internalise those concepts and techniques. The problem for the tutor is that, given this opportunity, the project topics chosen by students vary enormously, including, for example: simple board games, family relationships, household activities, tiny expert systems, adventure games and modelling the actions of simple machines.

In the project specification phase the student identifies the precise nature of the problem domain, its ontology and the kinds of processes that occur either in managing user interaction, or in doing internal inference, simulation, bookkeeping, etc. Advising students at this stage involves knowing both about all the domains and the kinds of things that are likely to be of interest to the students.

In the design and implementation phase the tutor needs to be able to relate statements about the domain to the selection of data-structures and operations on data-structures (e.g. representations and inferences). The tutor also needs to be able to relate descriptions of processes of user interaction or internal inference or simulation to programs that will run on the computer to handle input and output, manipulate data-structures, etc. In other words, even if the tutor is not actually writing the program, in order to advise the student at various stages from design to debugging, s/he needs to have all the knowledge that would be required of a programmer.

So an intelligent tutoring system able to advise students would need encyclopaedic knowledge about the world in which students live, and would have to combine the bulk of an automatic programming system with the ability to infer intentions in another agent from actions and half baked descriptions, and the ability to judge nicely how much advice to offer the student in order to be helpful without taking over the design.

The strategy of teaching by presenting materials then getting students to choose and solve a problem that *they* have invented is appropriate to many teaching situations besides programming. The requirement for essentially encyclopaedic common sense knowledge will therefore be present in intelligent teaching systems in such situations. In teaching mathematics, for example, which in principle can be an entirely self-contained formal discipline, it is in practice essential for most learners that they relate the abstract concepts to concrete examples from non-mathematical domains that they already know about.

CONCLUSION

For all these reasons we expect that it will be a long time before AI teaching systems can be called "intelligent", though we don't claim it will never happen. The major impact of AI on education in the short term is thus likely to more prosaic: not so much in the design of intelligent tutoring systems, NL front ends, or other systems that can take over some of what teachers do now, but rather in the use of AI languages, environments, and toolkits together with other developments in computing and associated technology. With the help of good teachers, AI languages and environments can already provide powerful teaching tools. But that's another story.

REFERENCES

1. S. Ohlsson, *Instructional Science*, 14, 3, 293-326 (1986).
2. B. Woolf in *Artificial Intelligence and Instruction* ed G.P. Kearsley, (Addison-Wesley, Reading MA 1987).
3. J.H. Larkin and H.A. Simon, *Cognitive Science* 11, 1, pp. 65-100 1987
4. A. Sloman, in *Research and Development in Expert Systems*, ed. M Bramer (Cambridge University Press 1985)
5. J.R. Anderson and B.J.Reiser *Byte* 10, 4 pp. 159-175 1985
6. W.L. Johnson and E.Solloway *Byte* 10, 4 pp. 179-190
7. R.Barrett, A.Ramsay and A.Sloman *POP-11: A Practical Language for Artificial Intelligence* (Ellis Horwood, Chichester 1985)

Theories of Learning In Intelligent Computer-Aided Instruction

Raejean T. Winans, Elizabeth T. Whitaker, Ronald D. Bonnell*

ABSTRACT: This paper examines six theories of learning and the relationship of these theories to intelligent computer-aided instruction (ICAI). A blackboard model for tutoring systems will be presented and used to illustrate what each of these theories contributes to ICAI. Skinner's Operant Conditioning, Gagne's Conditions of Learning, Piaget's Cognitive Development Theory, Information Processing Theories, Bandura's Social Learning Theory and Weiner's Attribute Theory are examined within the framework of the blackboard model. These theories form an appropriate background for the developers of an ICAI system.

INTRODUCTION

For over a century, psychologists have been studying the process of learning. Their empirical studies have led to several theories of human learning that have been applied to classroom instruction. ICAI has concentrated on the representation of knowledge and skills being taught, understanding the student's responses to the system, and has used a limited set of teaching heuristics to present the material to the student. This paper investigates the prospect of capturing the knowledge imparted by established learning theories and applying it to the *Tutor* of an ICAI system.

The components of a tutoring system have been identified by studying existing ICAI systems, Figure 1. A *Domain Expert* is needed to reason about knowledge in the problem domain. The function of the *Tutor* is to determine what information to present to the student and how to present it, based on a model of the student and the curriculum employed. The *Student Modeler* determines the student's present knowledge state, goals and plans, and strengths and weaknesses. All communication between the student and the ICAI system is controlled by the *Dialog Manager*. Each knowledge source reads and places information on a global database called the blackboard, and responds opportunistically to any changes on the blackboard, (ref 2).

The purpose of the *Tutor* is to determine *what to say*, *when to say it*, and *what to do next*. The knowledge provided by the learning theories supplies teaching strategies for implementing these functions.

THE LEARNING THEORIES

Instruction using *B.F. Skinner's Operant Conditioning* requires the selection of carefully controlled stimuli to prompt a response using reinforcement. Response frequency is controlled by the nature and timing of the reinforcements used. Learning is reflected by the change in the response frequency of a behavior.

Robert Gagne's Conditions of Learning identifies nine phases of learning which should be addressed when developing instructional material. The instructional needs for each of these phases and methods of testing can be determined based on the learning outcome desired.

Information processing theories identify learning as the process which transforms information from the environment into cognitive structures. Cognitive Psychologigists

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Information processing theories identify learning as the process which transforms information from the environment into cognitive structures. Cognitive Psychologigists have modeled these transformations and cognitive structures, developing strategies which can be used to improve the learning process.

Piaget's Cognitive Development Theory states that the interaction between the learner and the physical environment is the source of new knowledge. Education should be characterized by the use of methods that support the spontaneous research of the student. The concepts that can be learned depend on the cognitive development of the student.

Bandura's Social Learning Theory identifies the effect on an individual of the consequences (punishment or reinforcement) of a model's behavior. Behavior can be reinforced by direct reinforcement, vicarious reinforcement or self-reinforcement.

According to *Weiner's Attribution theory* an individual's motivation depends on his perception of the causes for his success or failure. A student who feels he is in control of events is inner-directed and self-motivated. Helplessness and apathy occurs in students who believe they have no control of their environment (outer-directed).

LEARNING THEORIES AND ICAI

Having knowledge of these learning theories and ways to apply them would allow the *Tutor* to choose an appropriate teaching strategy for a given situation, just as a human teacher would. These theories indicate the complexity and difficulty of developing and presenting a curriculum, yet the same development process can be used in many different domains. ICAI developers may be able to use this framework to develop shells for the *Tutor* which can be used for several domains. Figure 2 is a summary of how these theories apply to the major functions of the *Tutor*.

The theories suggest methods which are difficult or impractical for a human teacher to implement, but which may be performed easily by an ICAI *Tutor*. For example, the schedules of reinforcement recommended by Skinner are too frequent to be practical without automation.

These six learning theories provide a basis for developing instructional strategies which can be employed by an ICAI *Tutor*. A good *Tutor* should make use of the background knowledge provided by these learning theories. These theories also serve as a framework for evaluation of existing systems.

This paper is a summary of research which can be found in Winans, et. al, (ref 3).

REFERENCES

1 Bell-Gredler, M.E., Learning and Instruction: Theory into Practice, Macmillan Publishing Company, (1986).

2 Hui, A., Whitaker, E.T., Bonnell, R.D., A Blackboard Model for Tutoring Systems, USCMI Report Number 87-39, Center for Machine Intelligence, University of South Carolina, (1987).

3 Winans, R.T., Whitaker, E.T., Bonnell, R.D. Theories of Learning In Intelligent Computer-Aided Instruction, USCMI-88-05, Center for Machine Intelligence, University of South Carolina, (1988).

A Blackboard Model for Tutoring Systems

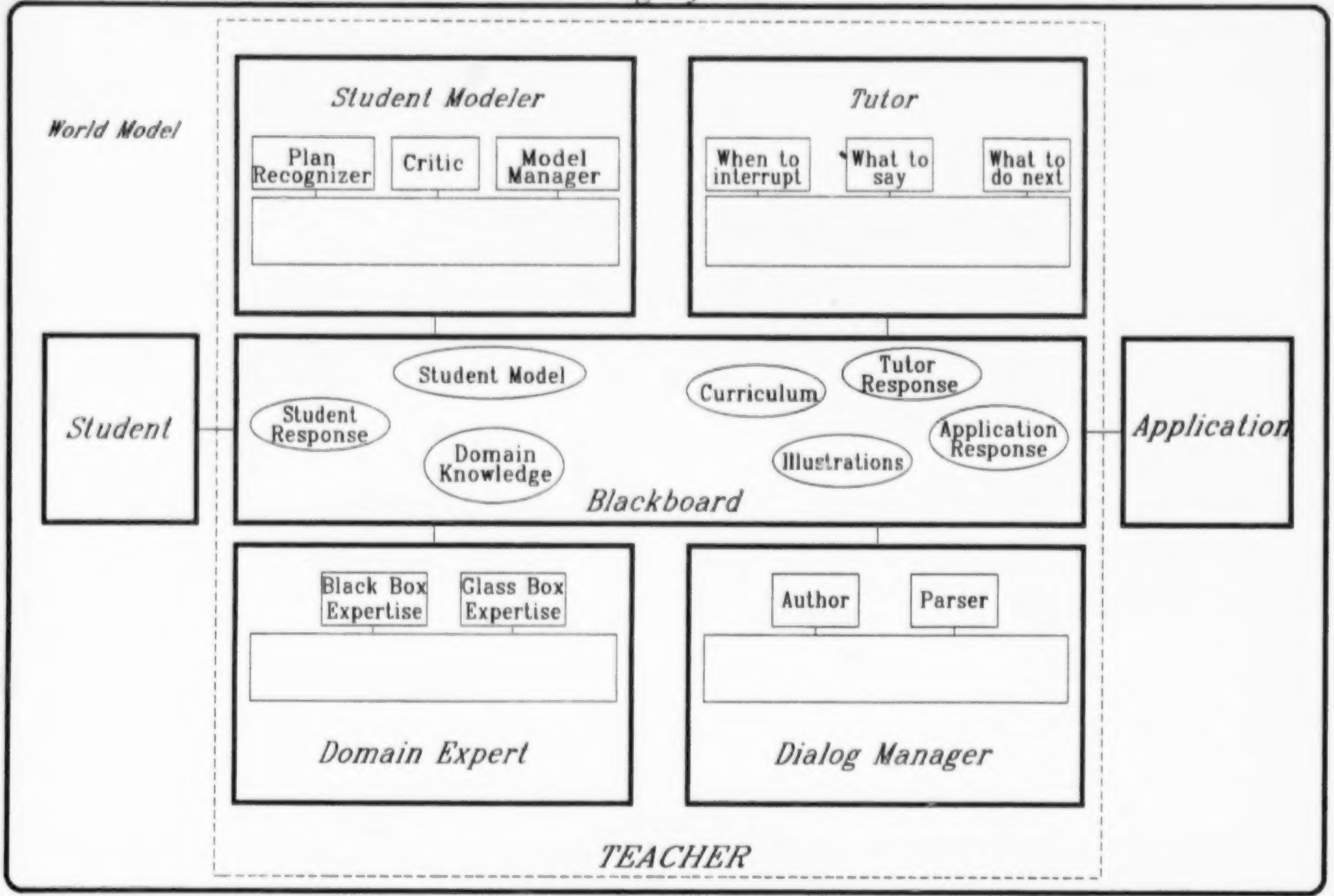
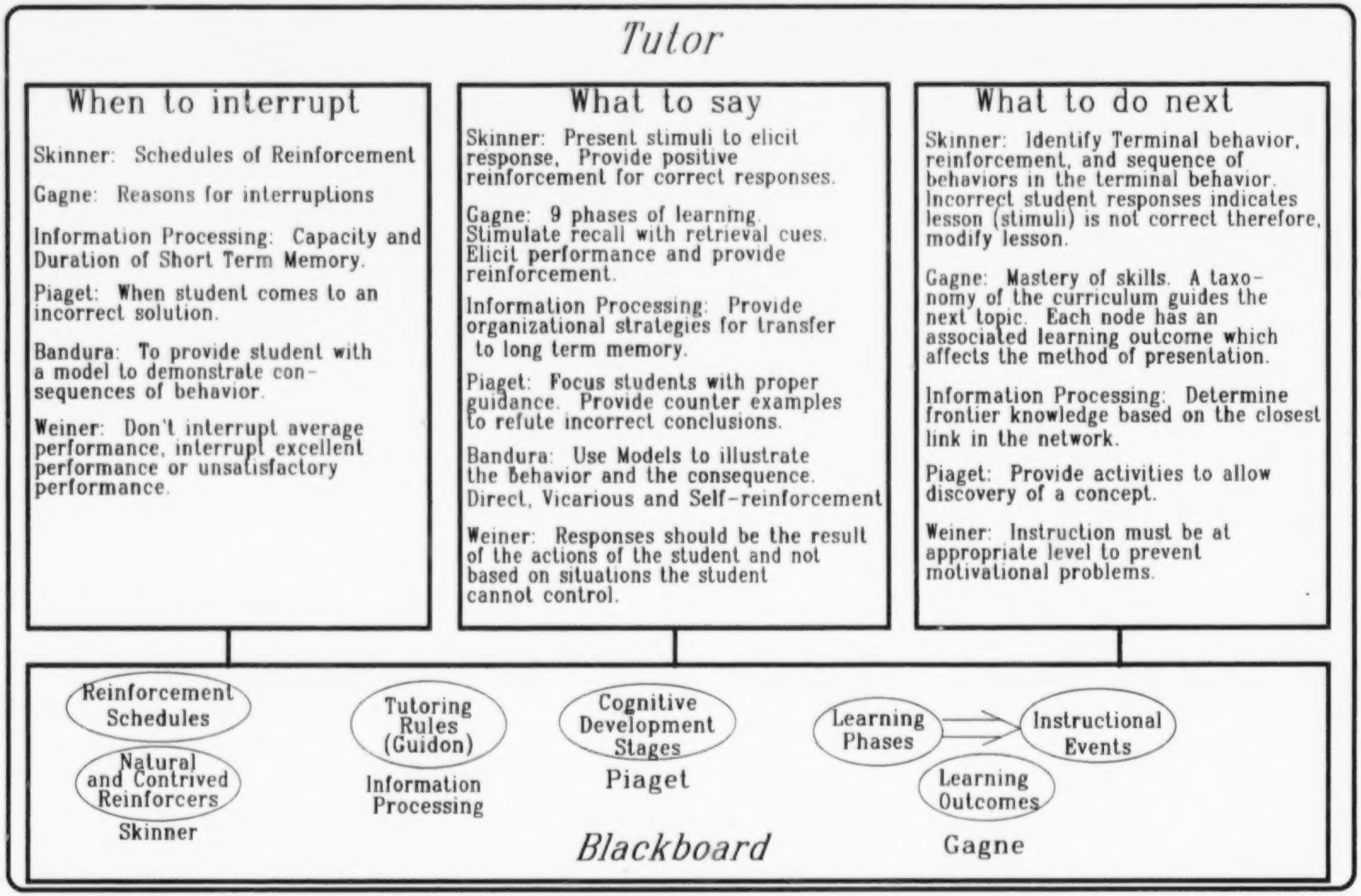

World Model
Student Modeler
Plan Recognizer
Critic
Model Manager
Tutor
When to interrupt
What to say
What to do next
Student
Student Model
Student Response
Domain Knowledge
Curriculum
Tutor Response
Illustrations
Application Response
Blackboard
Application
Black Box Expertise
Glass Box Expertise
Author
Parser
Domain Expert
Dialog Manager
TEACHER

Figure 1



When to interrupt

Skinner: Schedules of Reinforcement

Gagne: Reasons for interruptions

Information Processing: Capacity and Duration of Short Term Memory.

Piaget: When student comes to an incorrect solution.

Bandura: To provide student with a model to demonstrate consequences of behavior.

Weiner: Don't interrupt average performance, interrupt excellent performance or unsatisfactory performance.

What to say

Skinner: Present stimuli to elicit response, Provide positive reinforcement for correct responses.

Gagne: 9 phases of learning. Stimulate recall with retrieval cues. Elicit performance and provide reinforcement.

Information Processing: Provide organizational strategies for transfer to long term memory.

Piaget: Focus students with proper guidance. Provide counter examples to refute incorrect conclusions.

Bandura: Use Models to illustrate the Behavior and the consequence. Direct, Vicarious and Self-reinforcement

Weiner: Responses should be the result of the actions of the student and not based on situations the student cannot control.

What to do next

Skinner: Identify Terminal behavior, reinforcement, and sequence of behaviors in the terminal behavior. Incorrect student responses indicates lesson (stimuli) is not correct therefore, modify lesson.

Gagne: Mastery of skills. A taxonomy of the curriculum guides the next topic. Each node has an associated learning outcome which affects the method of presentation.

Information Processing: Determine frontier knowledge based on the closest link in the network.

Piaget: Provide activities to allow discovery of a concept.

Weiner: Instruction must be at appropriate level to prevent motivational problems.

Reinforcement Schedules
Natural and Contrived Reinforcers
Skinner
Tutoring Rules (Guidon)
Information Processing
Cognitive Development Stages
Piaget
Learning Phases
Instructional Events
Learning Outcomes
Gagne
Blackboard

Figure 2. The Blackboard Model of the Tutor

WHAT BEGINNING TEACHERS NEED TO KNOW ABOUT TECHNOLOGY: CALIFORNIA'S NEW REGULATIONS

C. Blurton*

ABSTRACT

The State Legislature of California recently passed a law requiring all beginning teachers to complete computer education coursework prior to receiving a "clear," i.e. permanent, teaching credential after July 1, 1988. The State Commission on Teacher Credentialing was charged by the legislation with specifying what computer skills new teachers must have to satisfy the requirement. This work has resulted in a set of Title Five Education Code Requirements specifying what computer skills teachers applying for a clear credential must have in California to become certified and a statewide debate about how teacher preparation programs ought to reform to provide appropriate instruction.

INTRODUCTION

In America, California has been at the forefront of public education infusing educational technology into its schools. This leadership has included, at various times, the establishment of regionally-based Teacher Education and Computer Centers (TECCs) to delivery inservice technology and curriculum training, local assistance grants to provide computer equipment and supplies to the public schools, demonstration and dissemination projects to develop model curricula for use with various technologies, the donation of a VCR to every K-12 public school in the state, the production of six Technology In Curriculum (TIC) manuals to provide educators with guidance in the selection and use of exemplary computer software and videotape, the establishment of summer technology institutes which have trained over 1,200 K-12 educators to effectively use computer and video technology in their classrooms, and the establishment of model schools projects to examine school environments rich with technology.

These initiatives have been the result of state legislation sponsored by enlightened senators and representatives who believe that technology, used appropriately, can improve the quality of public education. In keeping with this tradition of legislative leadership, California State Assembly Bill No. 1681, sponsored by Assemblyman Sam Farr and signed into law by Governor Deukmejian October 1, 1985, specifies that beginning July 1, 1988, candidates for a clear teaching credential in the state must satisfactorily complete computer education coursework that includes general and specialized skills in the use of computers in educational settings.

In order to realize the intent of the legislation, the California Commission on Teacher Credentialing (CTC) was charged with the task of establishing education code requirements specifying what computer skills should be required of teachers applying for a clear credential. To that end, the CTC established a Computer Education Advisory Committee to grapple with what the list of computer skills teacher preparation programs would be required to teach should--and shouldn't--include. This advisory committee included representatives from public and private

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institutions of higher education, the State Department of Education, school districts, business and industry, various educational groups including the California Federation of Teachers and the California Teachers Association, and consultants known for their expertise in educational technology.

EDUCATION CODE REGULATIONS

The regulations developed by the advisory panel are comprehensive. They require candidates for a clear teaching credential to have computer-based technology skills ranging from fundamental knowledge, e.g., how to operate a computer system, to discipline specific knowledge, e.g., how the new technologies can be used to enhance the delivery of instruction in an appropriate portion of the K-12 curriculum.

Each candidate must complete coursework in which he or she learns about and is required to identify a variety of issues related to computer-based technologies. These issues include access to, use, and control of computer-based technologies, potential economic and social impacts, the moral, legal, and ethical implications of the use of computer-based technologies in an information based society, and the potential impact such technologies may have upon the quality of life in a democratic society. The content described in this section of the new regulations parallels that typically found within "computer literacy" coursework. One difference is the lack of a requirement addressing the history of computer technology. Although originally included in the language of the regulations, history was deleted after some panelists expressed a concern that, although generally of interest, the history of computing has received too much attention in California's K-12 classrooms and should be de-emphasized in the regulations.

Each candidate for a clear teaching credential will be required to demonstrate knowledge of basic operations, terminology, and capabilities of computer-based technologies including the use of hardware, software, and system components for simple applications like word processing.

The new regulations require candidates to demonstrate an understanding of and ability to use, appropriate to their subject area and grade level, representative programs for instructional purposes from three catagories: (a) computer applications programs and tools such as word processing, databases and spreadsheets, (b) computer-assisted instruction such as drill and practice, simulation, and tutorial software, and (c) teacher utility programs such as test generators, grade books, and graphics generators. Programming languages were included, after much discussion, under section (a) as a "tool."

The language of the education code regulations specifies representative programs from the three groups as appropriate to the candidates' subject area and grade level. The regulations do not require each candidate to master each application or type of program specified, or be able to apply them all to every subject area and grade level.

California's teacher preparation programs will also be required by the new regulations to prepare candidates to demonstrate the application and use of a computer-based technology as a tool to enhance the development of problem solving skills, critical thinking, or creative processes. Finally, the education code regulations require that each candidate demonstrate the integration of a computer-based application into instruction in his or her subject area and/or grade level. This, the panelists thought, would help ensure students the opportunity to develop curriculum that incorporates computer-based technology into the instructional process.

STATEWIDE DEBATE

After the Title Five Education Code Regulations were written and disseminated, California's over 70 public and private institutions of higher education with accredited teacher preparation programs began the process of reforming their curricula to meet the requirements of the new regulations. This process, the focus of much discussion and debate among teacher educators, is still underway with a wide variety of institutional responses being prepared for the Commission on Teacher Credentialing (which must approve each). This process has forced each of the more than 70 institutions to reexamine course content in existing methodology courses, to upgrade computer laboratory facilities, in some cases, to hire new faculty. In addition, many institutions have begun the process of retraining faculty who entered the profession prior to the influx of computers and computer-based technologies like interactive videodisc into the classroom. Within the California State University system, which graduates more than 70% of the credentialed teachers in the state, a new professional organization has been formed by faculty--the Association of State Technology-Using Teacher Educators (ASTUTE)--to address the dissemination of information about technology in teacher education and to organize and host teacher education faculty training workshops and conferences.

The new teacher regulations promise to have far reaching consequences for teacher education programs across the state, educational practices within California classrooms, and ultimately for California's students. California's schools have heavily invested in microcomputer technology. A report for the State Department of Education by Saul Rockman of Far West Laboratories estimated that there were 115,500 micorocmputers in K-12 classrooms across the state in 1986. The availability of trained professional who will be able to put this technology to better, more productive use may increase the value of that investment. With all teachers learning about the potential of microcomputer-based technologies to enhance the delivery of instruction, it is expected that California's schools will see an enhancement of K-12 instruction through the application of new ideas and techniques applying computers and computer-based technologies to instruction.

IT SUPPORT NETWORKS FOR CURRICULUM AND STAFF DEVELOPMENT

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ABSTRACT

Education and training agencies are starting to make use of new technologies to support the efforts of staff in developing new courses and curricula. Teachers and trainers need to 'own' their curriculum and the new skills. Information technology can facilitate this ownership by supporting networks of people and institutions with on-line access to databases, electronic mail and notice boards. This paper describes the growth and support of networks for pre-vocational education and training in Northern Ireland and the role of the proactive support unit, the Regional Curriculum Base, which makes use of the new technologies. The work is illustrated with three examples:

(i) The sharing experience of curriculum change through dissemination, evaluation and modification of learning materials.
(ii) The display of news and the promotion of discussion through electronic notice boards and mail.
(iii) Support on the implementation of a new course across the Northern Ireland region. The course requires teachers and trainers to apply new practice drawn from the Review of Vocational Qualifications (RVQ).

The technology exists to give continuous distance support. Discussion will centre on the necessity to set targets so that appropriate management support, resources, and training are established. These facets of technology provide access to learning materials, sharing of documents and discussion of teaching strategies. The advantages of these new methods of communication are highlighted. The opportunities for extended participation in shaping the curriculum are examined.

INTRODUCTION

Changing patterns of course provision and approaches to curriculum delivery are making demands on teachers to develop new skills and to understand new procedures in their practice. In the UK RVQ has heralded the development of a new framework for vocational education. In a similar way the Certificate of Pre-Vocational Education (CPVE) is doing this for pre-vocational education. However, these frameworks will not become reality for the learner merely by being expressed, however sharply, in written form. Delivery is a product of organisational arrangements and individual effort. Moreover, the openness of the system and facility for transfer expressed through the concept of national credit accumulation requires teachers to understand curriculum in a much broader form than before. Teachers are likely to feel isolated where they are being asked to abandon long established practices based on patterns of knowledge/skill presentation. They must be given opportunities for developing their expertise through peer group development of curriculum. The translation from stated curriculum aim to learner uptake depends on

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organisation management and individual teacher effort. These two facets of delivery need to be supported in ways which maximise opportunities for participation. It is here the electronic networks have a major role to play.

The Regional Curriculum Base for Northern Ireland (RCB NI) is part of a regional network for staff and curriculum development within the Further Education (FE) sector (ref 1 & 2). Three illustrations are now given to show how RCB NI has used new technology to support networks for staff and curriculum development.

ELECTRONIC BASIS OF NETWORKING: ResCue

ResCue is the national electronic network for pre-vocational education and training accessed through The Times Network Systems Ltd (TTNS). It was created by the RCB NI in 1986 on behalf of all RCB in the UK. More than simply a database, ResCue has notice boards and the electronic mail facility of TTNS, as well two expanding catalogues of material (currently over 4,000 items) for pre-vocational education and training which help teachers to integrate the basic skills and contexts of work into the learning experience (ref 3 & 4).

LEARNING MATERIALS

The first illustration of the use of new technology is in the sharing of curriculum change through dissemination, evaluation and modification of learning materials.

RCB NI, in common with all RCBs, has developed a resource support unit. It contains a wide range of materials aimed at providing teachers with a broad sample of relevant and current staff and curriculum development material. These include books, journals, broadcasts, video, software, multimedia packs and even small pieces of hardware. They are catalogued especially for pre-vocational education. There is also a range of unpublished teacher produced assignments. Teaching staff are encouraged to evaluate these learning materials, and to share their evaluations. Through the processes of finding, evaluating and modifying learning materials the teacher is exposed to the changes in curriculum and the move towards resource based learning.

Although many teachers do visit the RCB many more find it difficult due to lack of time and travelling restrictions. It would require teachers in the furthest institutions to travel 98 miles. The RCB therefore computerised the resource catalogues into databases available on-line at any time, and any location.

Let us take the example of a teacher, Mr Smith, going on-line to ResCue. He is a course team leader for CPVE in the occupational group 'Health and Community Care'. He enters these keywords for searching: "5.1 AND PRACTICAL" to select items for his occupational group and with 'PRACTICAL' basic skill.

The response is:

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      30 Occurrences ...
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A brief description of each item will appear when requested, for example:

ResCue-RCB Assignment Catalogue
AC=PRA1-003 Manipulative Skill
An 8 page assignment. Series of tasks to help students understand how young children have to learn how to use their hands skilfully and how old people have to cope with hands which have become less mobile, by ILEA Curr Dev Proj. Date indexed 86/2 level=1
Occupational group=5.1 5.3 PRACTICAL SOCIAL
++ Available instantly by TTNS mail.

Information on the 39 assignments is saved onto a disk, and printed out when off-line. When the list is reviewed at the next team meeting an assignment is chosen. Mr Smith returns on-line. He chooses the input section and orders the assignment which is immediately delivered by electronic mail. He moves to TTNS Mail Section, saves the assignment onto the floppy disk and goes off line. He then uses his word processor to edit the assignment to suit his learners by changing the names, locations and adding a section on assessment and additional resources available. Finally the assignment is printed ready for use.

NEWS AND DISCUSSIONS

The display of news and the promotion of discussion through electronic notice boards and mail is the second illustration of the way in which new technology can support the efforts of staff in developing new courses and curricula.

ResCue currently contains six notice boards, some national and some regional, and more are planned. The three national notice boards focus on a topic or a course: CPVE, Information Technology across pre-vocational education, and news about ResCue. Regional notice boards provide support within particular RCB regions in the UK, eg, North West England. Each notice board consists of a menu with 10 options such as the one of IT illustrated in Figure 1.

Notice boards are run by an editor who is responsible for finding articles and ensuring accuracy. The articles need to be short 10-60 lines of text, with a descriptive title. An additional feature of ResCue's notice boards is the Automailing option, which automatically mails each article to any Dialcom mail system (eg, Telecom Gold) on request.

IMPLEMENTING A NEW COURSE

The final illustration shows the ways in which new technology has been able to support the implementation of a new course across the region.

The course is 'Basic Skills in Catering'. It was able to use the existing electronic network developed by ResCue. Cluster group training introduced course deliverers to the use of the technology and supported their peer group development. In this way they could share curriculum/training problems and development of classroom materials in response to student needs.

ADVANTAGES OF ON-LINE INFORMATION

The advantages of electronic networks lie in supporting participation through increased speed and density of communication while remaining on site. Information circulated on-line to groups drops the tedious steps of copying, collating and postage. Also each receives a top copy. Any information such as documents, searches, data files and messages can be processed by the reader's own equipment. Access can be made available to any member of any institution as most already have the equipment necessary. Then the teacher can not only view the information but actively select items to suit their interest or send IN a request at any time. The information in the electronic network and the system (TTNS) also has many other applications for students as well as staff: languages, careers, etc. (ref 5).

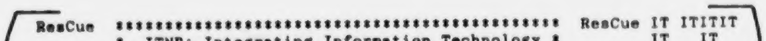
However, these advantages of efficiency and access can only be achieved if they are also aspired to by the educational institutions, agencies and support units. Targets need to be set so that appropriate management support, resources and training are established. An evaluation of ResCue in 1987 showed that many teaching staff were unaware of their institution's membership of TTNS (ref 6). The management will need to support the allocation of resources of hardware, software subscription, phone budget, support staff and training.

CONCLUSION

IT support networks do provide opportunities to extend participation in shaping the curriculum. The bottom line is the number of staff involved in the uptake of new curricula. This paper has shown how participation, with the opportunity for peer group development, can be extended with an electronic network such as ResCue.

REFERENCES

1. FEU, The regional curriculum base initiative (FEU, May 1984)
2. FEU, Focus on dissemination (FEU, Focus No 6, 1987)
3. N Davis, Educa, 69, 8-9(1987)
4. N Davis, Aspects of Ed Tech XXI(Kogan Page, 1987)
5. TTNS, The 1988 TTNS handbook (The Times Network Systems Ltd, 1988)
6. N Davis, F Munday, & D Locke, First evaluation of ResCue for RCB Directors (FEU internal report, 1987)



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ResCue  *********************************************  ResCue IT ITITIT
        *  ITNB: Integrating Information Technology *         IT   IT
        *********************************************         IT   IT
       Integrating IT is about putting IT to work for us.
  This notice board displays examples, gives news and views.
Please send in your comments, ideas, opinions and news to YNJ003.

Key a number for an article:

* 1  Introduction to this notice board, by Niki Davis        Oct 01
* 2  Computer Aided Profiling resources - CAP fitting        Oct 01
* 3  Healthdata "off-line", by J Whiting                     Oct 14
* 4  Computer applications competition by Kent Uni.& Barclays Nov 13
* 5  Management of IT in one college & MITFE by TG McCann    Dec 18
* 6  CAL/FE initiative at the House of Lords                 Dec 20
* 7  Integrate IT? Yes please!  by A.Dip.(FE) class          Jan 01
* 8  Managing and developing IT resources, by J Megarry      Jan 01
* 9  Computers in Adult Basic Education (CABE) Association   Jan 08
* 99 Automailing options (ie. Receive Noticeboard updates automatically)

Or type a command.  Command  HELP  for a list
ResCue>
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Figure 1. Menu of the IT Notice Board

Portland Public Schools' Teacher Program for Technology Awareness

by Trudie Mishler*

Abstract: Portland Public School District's first computer class for teachers was designed by university researchers who contracted through the county education service district. It was modified for the district by the cadre of of teachers who were trained to teach it. Several sections of this class were held at different locations around the District. In the three years since that time, the inservice offerings have grown to 18 different classes per term.

Teachers receive credit toward the renewal of their teaching certificate. The District's Instructional Technology Unit has worked with Portland State University to offer university credit for the classes.

Classes offered include software selection, integration into the curriculum,. and classroom management. The offerings change as old classes do not fill and new needs arise. Classroom teachers, with the aid of curriculum support personnel, develop the new classes. We have found this to be a highly successful way to share educational uses of the computer.

Present Course Offerings

The Contents of Portland Public Schools' winter courses include (with some overlap):

- Word Processing, Data Bases and Spreadsheets as Teacher Tools - 12 classes
    - -Word processing for lesson plans, form letters, instruction sheets etc.
    - -Spread sheets or data bases for grades or other student or class record keeping
- Word Processing for use with students - 4 classes
    - Word processing in the the writing process - all grades
    - Book publishing

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- Integrating technology into the curriculum - 3 classes
- Desktop Publishing - 1 class

Equipment Used in these courses are:
Macintoshes - 4 classes
IBMs - 3 classes
Apple //s - 12 classes

History of Technology Inservice

The history of Instructional Technology began when a commitment was made by the District to budget money for hardware and software support. This was followed by the formation in 1983-84 of a new unit of the Curriculum Department, the Instructional Technology Unit. A high school computer teacher was hired to staff the new unit. More computers and new, useful software increased the demands for support. By 1986 two more teachers had been added to the unit.

BASIC programming was being taught by some District staff under local university auspices. As instructional software came into the market, the focus changed to the computer as a tool for teachers and students. In keeping with this new direction, a course in basic instructional computer literacy for teachers was taught to a cadre of 20 classroom teachers. The core of our Inservice instructors came from this original cadre. Their salaries came from the budget for the new Instructional Technology Department. The original course is still being modified by the Inservice staff as they see a need. Revisions are done in summer workshops. The present goal of our inservice classes is "to offer instruction in the uses of computers in education" to District teachers.

Development of New Courses

Classes are developed in the Portland District by instructors to meet the needs of District teachers. Ideas for new classes come from teachers, building computer coordinators, and curriculum specialists . Courses are designed by the instructors, and by teachers who have expertise in using popular software and associated materials.

Location and Materials

Class sites are selected by the amount and type of equipment available and by the demand for a class in a given area of the District.

A computer contact person can recruit teachers in a building to take a class at their site. Additional equipment for the class is supplied by the Instructional Technology Unit.

Materials, software and texts, are selected and agreed upon by the Inservice teacher and the staff of the Instructional Technology Unit. Class materials and software are purchased and delivered to the site by the Instructional Technology Unit.

Other considerations

There are 3 main advertising paths that are used to inform the District teachers about classes:

- A poster of pertinent course information produced by the Instructional Technology Unit and sent to each school
- A list of the courses included in the sponsoring university's bulletin of course offerings
- A description of Instructional Technology courses along with other District offerings, published by a central office

These course descriptions are distributed to each teacher or posted in each school. Classes are also promoted in the unit's monthly newsletter.

Our courses must be approved by the local university for our teachers to get university credit for them. A full description of the course (syllabus), materials and bibliography must be submitted to the college. A resume for each of our instructors must be accepted and on file at the university.

Teachers may choose no university credit, graduate or undergraduate credit, or inservice credit (which applies to a renewal of their teaching certificate). Teachers pay no fee for a course if it is taken for inservice credit or audit.

Each session of a class must be evaluated by the participants. University and District forms are filled out by participants at the end of each term. These forms are collected and returned to us and the university. We examine copies of all the evaluation forms and discuss ideas and concerns from them with our instructors.

Special inservice Workshops

For three years a series of one to two hour classes taught by our instructors has been made available to all District teachers. These sessions are designed to capture attention, generate excitement and expand District teachers' awareness of the uses of computers in education. The sessions are held on a teacher inservice day or on a Saturday. We have keynote speakers from our area, and use doorprizes and other incentives to get evaluations back on the sessions.

Classes for teachers from an individual school can be scheduled by a principal and the computer coordinator through our unit. These classes are designed by us and the school computer contact person to meet specific building needs. Often the staff at a building is surveyed for their needs and interests. Regular building staff meeting time is used for these classes

Problems and Solutions

Inevitably glitches and problems arise in running an inservice program. Some of the problems we have had to solve include:

• Problem: Having enough printers to accommodate a class of 16 teachers.

∞Solution: We purchased printer switch boxes and installed them at the sites of our classes.

•Problem: Offering classes at times of the day and week which are convenient for busy teachers.

∞Solution: We try to offer classes consistently on two days a week, late afternoon and evening.

•Problem: Adjusting for a wide range of experience levels among District teachers.

∞Solution: We rate our classes as beginning, intermediate and advanced, and counsel teachers into appropriate classes.

•Problem: Developing and offering courses which are not filled (teachers do not see a need for the material or are not ready to use data bases, for example)

∞Solution: We include an introduction to the new class in an existing one or work to raise teacher awareness. (Sometimes we run a class that is not full in the hopes of generating interest by contagion).

• Problem: Having more courses to offer in a year than our funds will support.

∞Solution: We try to prioritize our classes by popularity and potential.

MOVING EDUCATION AND ITS ADMINISTRATION INTO THE MICROCOMPUTER AGE

William Gattis* and Nolan Estes**

ABSTRACT

The numerous areas in which microcomputers can be applied in educational administration are receiving increased interest, and a growing number of educational institutions are using small computers in one or more of these areas. However, of over two dozen types of applications of microcomputers in administrative areas that have been identified, and in which schools have expressed an interest, only a few are supported by the majority of commercial applications software products currently available. Further, the investments that are necessary in order to implement administrative applications throughout a medium or a large school district are substantial. The rapid evolution of the capabilities of small computers and operating systems, the relatively short life cycle of hardware and operating systems, and the lack of transportability of much applications software from older to newer systems, is becoming a significant barrier to more extensive usage of small computers in these and other areas of education.

INTRODUCTION

A recent trend in K-12 schools in the United States is the growing interest in uses of small computers for a variety of administrative and instructional management functions. In several large states, and in a number of medium and large school districts, planned expenditures for microcomputer-based administrative systems during the next school year equal or exceed those expenditures planned for classroom computers to be used for student instruction.

A summary of significant areas or trends in these types of applications includes the following:

1. A growing interest in uses of small computers for instructional management -- both for software-based instruction, and for management of instruction using traditional print-based materials.
2. Wider uses of small computers in educational administrative functions, including the "basic four" applications of student enrollment, scheduling, grade reporting, and attendance, as well as growing interest in over two dozen additional applications in other categories of administration, including finance and purchasing, personnel data bases, student data bases, access to central office mainframe computer systems, a

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variety of textbook and school equipment inventory systems, word processing, guidance functions, and library services.

3. Use of networked systems of small computers to share data resources.

4. Improved processes and techniques for meshing software applications used for instruction, with software systems used for instructional management and administration.

The continuing development of small computers with faster processing speeds, larger amounts of random access memory at more economical costs, faster and less expensive mass storage devices, and more sophisticated operating systems, continues to expand the areas of educational administration in which microcomputers can be used effectively.

MAJOR CONCERN

A major concern is becoming increasingly evident among many of these same large school users, however.

Most of these school districts are planning to make major investments in computer hardware, operating systems, and applications software over the next few years. And yet, the relatively long-term focus most school districts must take in terms of investments in major systems and processes is often in conflict with the rapidly changing technology of small computers. New CPU's, new operating systems, and the rapid obsolescence of many hardware and software products, are all major concerns for school officials faced with major investments in this area.

The implementation today of a typical microcomputer-based system for use district-wide in a metropolitan school district with a fifty thousand student enrollment, for instance, can involve an investment of as much as six million dollars. Computer hardware costs can account for as much as sixty to seventy percent of the initial investment, with software licenses, hardware and software service contracts, and supplies making up the balance. Additional significant costs to a school system include training of personnel, and adaptation of other related or interfacing systems, procedures, and methods in the school district to go with the computer-based processes.

However, in as little as two years or less from the initial installation, expansion of these systems to additional sites, acquisition of additional compatible hardware or peripherals that might be desirable, or implementation of additional applications software or of updated operating systems, can be difficult or impossible due to the continuing evolution of computer systems and the replacement by manufacturers of older models with new ones.

On the one hand, the continuing development of new and improved models offers increased performance and lower costs; yet on the other hand, a major school user can find that as a result of this progress, a substantial investment in a microcomputer-based system can become increasingly difficult and expensive to maintain.

For a user, betting on the longitudinal compatibility of current computer and software products with newer systems that lie a few years in the future can be very risky.

A growing number of medium and large school systems in the U.S. are asking vendors about these issues of compatibility, software support, and system maintainability, prior to making major investments in these systems.

And an increasing number of school systems are delaying, or scaling down, major purchase and implementation plans because they are not receiving the assurances that they want.

EXPLORING A SOLUTION

The rapid cycles of continuing innovation in computer technology, and the resulting obsolescence of investments in computer systems and software, are not new. They have been facts of life for computer users in industry since the early 1950's.

For a commercial enterprise that depends on computer systems for design, manufacturing, distribution, or accounting processes that are central to a profitable business, the economics of doing business, and the promise of increased efficiencies, greater production volumes, or improved quality, with the resulting prospect of growth in sales, increased revenues, and improved profitability, can justify an expensive transition to newer upgraded systems.

However, in education, revenues are not often directly responsive to improved efficiencies, or to improved quality of the end product. A decision to replace serviceable but outdated systems with newer ones is seldom as clearcut as in a business enterprise. Educational institutions typically use existing facilities and equipment for a far longer period than one would find in a business operation.

The central issue is one of compatibility among different computers and operating systems -- compatibility not only laterally, across different current systems, but longitudinally, into the future, as well. There is clearly a need for improved techniques for achieving compatibility among various computer systems.

Frequently, when the issue of compatibility is raised with regard to computer systems, various standards are presented as a solution. And certainly, we have numerous standards today in the industry, which partially address these concerns. Some examples of current standards are: media standards such as the 5 1/2 inch floppy diskette and the various magnetic tape formats; language standards such as BASIC or COBOL; commonly used operating systems; and information interchange standards such as the ASCII code or various communications protocols. However, these standards, while worthwhile in their own right, invariably impose limitations for both users and developers of applications software.

There is another approach to the issue of standards, and it is an approach that has been successful in another area of the computer industry.

That approach to standards does not depend on language, or media, or operating system standards. Instead, that approach depends on developing methods of defining specific applications envelopes for computer systems -- the "solutions" that are designed for specific computer users -- not in terms of individual programming languages, or operating systems, but rather in terms of carefully defined data structures that can be designed and developed independently of any specific computer hardware, programming language, or operating system.

These types of data structures deal very specifically with individual and unique applications, and with the many branching, graphics, text, and user interaction functions that are unique to a specific application. In their design, they deal only in a general way with the capabilities of individual computer systems. The specifics of interaction with individual brands of computer hardware and operating systems must be addressed, of course, and this is accomplished through a general-purpose adaptive software utility developed for each individual computer system, which interprets the elements of the data structure, and drives each individual computer system accordingly.

This concept is not new, and extensive and successful implementations of the concept have been developed in other areas of the computer industry.

One key to success with these types of data structures is that, in order to be generally useful, they must be based on a common threshold of capabilities that extends across the various computer systems that will be used. Once established, however, these processes are extensible -- that is, they can be extended to take advantage of new capabilities without obsoleting earlier subsets of functions on which earlier applications depend.

The issue of standards -- the right kinds of standards -- is a critical one for those engaged in the uses of computer systems in education.

It is time to take a serious look at some realistic alternatives to current practices.

THE TECHNOLOGY OF THE FUTURE: WHAT WILL IT LOOK LIKE?

Dr. Charles W. Fowler, Superintendent of Schools, Sarasota, Florida, USA

ABSTRACT

It is, of course, an immediately discernible non-sequitur that at an international conference on ***technology*** one presents a ***paper*** to the distinguished gathering. The anomaly, however, serves to underscore the essential premise of this presentation: we are not yet using, well, the technology which exists; therefore, the "future" technology is already here. To belabor the obvious, this is not a scholarly treatise on an obscure aspect of technological life. Rather, it is a pragmatic view of technology by an American school superintendent who is expected to provide a contemporary approach to the education of 50,000 children and adults.

DISCUSSION

It is altogether appropriate that we are meeting in Great Britain. Ned Lud was one of a group of English workmen in the early 19th century who endeavored to prevent the introduction of labor saving machinery by burning factories and destroying machines. A derivative of his name is now applied to any who seem to resist the use of newer technology. In examining the extent to which American educators and school systems effectively use existing technology, as a means of predicting future technological developments, one must conclude that Luddites are loose in our land!

My comments on the lack of utilization of already existing technology are not lightly made or intended as, simply, passing observations. The technology of the future will clearly be strongly influenced by the extent to which the technology of the present is used. What is it that causes us, and indeed, the Luddites of centuries past, to resist new technology? I can think of at least two examples from my own leisure-time activities. While not very good at it, I enjoy playing the pipe organ. I am intellectually conscious of the fact that a Moog Synthesizer, through cybernetics and electronics, can create, artifically, far more varied instrumental sounds than even the most elaborate of pipe organs. However, I prefer to sit at the console of a 38-rank Moller pipe organ, built decades ago, and play away at the reed and flute sounds, which don't begin to simulate the sounds of the "true" instruments as well as a synthesizer could. Similarly, I enjoy cooking. I know that with my home microcomputer, I could easily build a data base of recipes and then input the day's variables for computer generated suggestions. For an entree, I could input the number of persons dining, the length of time available for cooking, the approximate amount I am willing to spend, the meats which should be excluded from consideration because of dietary or personal preferences of the guests, and also specify that it not be a meal which I had served to anyone in this particular group of guests before. The computer would then present me with the options available for meeting that set of specifications. Do I do that? No way! I sit down with four or five cookbooks and daydream my way through them, salivating over what is new and different, but, in most cases, serving what is traditional, familiar, and easy!

The apocryphal story of a great sea captain from the last century punctuates my theme. Captain John Hull faithfully delivered his ship's cargo, in excellent condition and with on-time performance, all around the world. He was often asked the secret of his ability to navigate. He'd reply, "Well, I go up on the deck at night and look up at the stars; I smell the wind and feel the way that it's blowing; I feel the pitch and the roll of the waves--and, then, I set my course." Soon, however, word came to the owners of Captain Hull's ship that the insurance company would no longer insure any ships that were not using the most modern, scientific methods and instruments of navigation. So, after 30 years on the sea, Captain Hull had to go back to school. He worked hard, though, and graduated at the top of his class, mastering all of the most up-to-date equipment and charting techniques. Back on his newly-insured ship, someone would ask him how he navigated now. He would reply, "Well, I go down into my cabin and get out of my charts and compass. I get my readings and do all my mathematical calculations. Then, I go up onto the deck. I look up at the stars. I smell the wind and feel the way that it's blowing; I feel the pitch and role of the waves--and, then, I 'correct' those calculations."

The gap between potential and actual use will, in large measure, determine the technology of the future. No group of people in the world will have greater influence over that future than those at this Conference. For, the extent to which school staffs and students are comfortable with the technology of today establishes the foundation for the use of educational technology tomorrow. There are four existing or threshold technologies which I believe should significantly influence educational technology today and in the immediate future: (a) authoring systems, (b) interactive, computerized video, (c) telecommunication with data bases, and (d) artificial intelligence or "expert" systems.

In an article in Kappan two years ago, Professor Alfred Bork of the Univeristy of California, summarized for us the problems we all recognize in today's educational micro-computer software: (1) failure to make use of the interactive capabilities of the computer, (2) failure to use the computer to individualize instruction, (3) use of extremely weak forms of interaction such as multiple choice questions, (4) too heavy reliance upon text processing, (5) too-heavy reliance on pictures which play no role in student learning. (6) treatment of the computer screen as though it were a page in a book, (7) emphasizing entertainment over education, (8) content that does not fit anywhere in the curriculum, (9) complicated instructions, and (10) use of materials that fail to hold students' attention.

In America, we are also familiar with the litany of reasons that these well documented problems will not soon be rectified: (1) the absence of significant profit margins in authoring and marketing educational software, (2) the continuing incompatibility of different hardware and disk operating systems, and (3) the significant disparities in curricula content, state-to-state and district-to-district.

An answer to some, but not all, of the above problems would be to employ teachers who were capable of writing software which could be both responsive to the very specific learning needs of their particular classes, and also able to harness the tremendous technology which is available to help students learn with enthusiasm and long term retention. In a very practical sense, however, the mainstream of classroom teachers in America will not develop the skill of programming to a level to meet these instructional needs. Commercially-prepared "authoring systems" offer even the teacher who is a neophyte with computers the opportunity to design personalized, appropriate educational software for his or her classes. McGraw Hill, a leading American publishing firm, has made a significant entry into this field, along with others. An authoring system permits someone without a knowledge of programming to write "programs" by selecting parameters and inputting the appropriate content. These systems will become increasingly sophisticated, offering more and more graphics and greater interactive capabilities.

Some teachers are already applying the principles of authoring systems by using commercially prepared software, such as data bases and spreadsheets, to achieve the same purpose. For example, a teacher of economics can use an electronic spreadsheet for simulation purposes (e.g. creating a series of "What if. . ." routines on the spreadsheet for a mythical manufacturer where changing prices, labor costs, advertising promotions, designs, etc., result in programmed changes in the profit margin of the company). An authoring system takes basic, multi-application software and enhances it with powerful options. The potential will soon exist for teachers to go home and create an interactive computer application using an authoring system, and load it into a classroom drive for use by the entire class the next day. This will be no different from the lesson or test preparation work carried home by the teacher of yesterday. Instead of a mimeographed worksheet, however, the product of the authoring system will be a disk which can be individualized to levels of difficulty appropriate to the needs of a variety of children within the same class.

Interactive, computerized laser disc displays represent the merging of two formerly independent technological developments: the video disc and the microcomputer. Through the microscopic pits located within the video disc's tracks, a laser can read and transmit both video and audio display. The current machines are already capable of giving access to as many as 54,000 separate images on each side of the disc, with a two to fifteen second rate of access to any image. When interactive with a microcomputer, a powerful learning tool is created. Graphics have become an important part of the computer technology because even the civilization of ancient China recognized that "one picture is worth a thousand words." The video or laser disc, however, has the tremendous advantage of displaying actual, rather than simulated, graphics. This difference is vital in areas such as biology, history, foreign languages, industrial arts, etc. Slow motion displays of the division of a cell or differing chemical reactions from alternative mixtures of chemicals, can all be done at an individual student station without the need for the traditional, time consuming, and expensive, laboratory setups.

Certainly, the prospects of using this medium are not limited to high level sciences. Bank Street College, in New York City, has developed a program called "The Voyage of Mimi" which presents a variety of scientific concepts for young children, utilizing both video tape and computer technology. The United States National Aeronautic and Space Administration has given permission for the use of its programs on interactive videodisc/computer applications. In all of these uses, a vital distinction is being made and that is the distinction between a "viewer" and a "learner". One of the great fears about television as a medium is its passivity. Whether illustrations in a text, animated graphics, or motion pictures, students certainly can be learning from viewing--but there is no instant feedback on whether that learning is taking place. With interactive video, we have the potential for relatively instant feedback on whether learning is taking place. Most importantly, the student, himself, has that feedback. Interactive video presages a new era in learning which will combine the skills of reading, listening, viewing, and participating.

Despite former Harvard University President James Bryant Conant's advice to the contrary, the average high school in America enrolls fewer than 500 students. The diseconomies of scale, coupled with growing pressures on the tax dollar, mean that many high school students are preempted from access to important learning resources. The "information explosion", which is so evident in today's businesses, is no less real for thsoe of us who must prepare the future citizens of the information age. School librarians and classroom teachers seem forced to make a Hobson's choice in selecting learning materials for our students. Telecommunication access to national data bases offers significant hope out of that dilemma. If a school can afford a telephone line and a modem-equipped micro-computer, it can give its students access to some of the most sophisticated data bases in the world. Dialog, operated by the Lockheed Missiles and Space Company, is one of our nation's largest, with over 100 separate data bases available to its subscribers, from the Magazine Index of America's most commonly distributed periodicals, to book reviews, to complex data bases in medicine and other sciences. Students can obtain either brief bibliographic citations of information of interest, or complete on-line or off-line printouts of the text which they seek. The current major problem with this technology is the cost of maintaining the data base and, thereby, the on-line costs to the school. Dialog rates vary by data base, for example, but range from $15 per hour of connect time to over $300 per hour. The provision of universal access to major data bases must be an immediate consideration of our Federal and State governments if schools can even hope to prepare students for an information age. Such an insightful step by our governments would make the "library" collection at the poorest, rural school in America equivalent to that in the wealthiest, suburban community.

The "frontier" in the communication sciences is what has been labeled by the Japanese as the "Fifth Generation Computer"--a computer which, in the words of some, will "think". Two books which I would commend to you if you have not read them are The Fifth Generation by Feigenbaum and McCorduck and The Cognitive Computer by Roger Schank. Benjamin Bloom, an eminent American scholar at the University of Chicago, has stressed the need to teach students thinking skills, going beyond mere recall of factual data to a higher order of skills such as analysis, synthesis, and evaluation. In many respects, these higher order skills are needed in the computer technology. Even the least expensive computer can recall data it has been given. The ability to analyze, synthesize, and evaluate data, generating new theories and concepts, is the computer ability which artifical intelligence hopes to create.

Also called "expert systems", these programs have received cautious acclaim, already, in the field of medicine. Used as an aid to a physician in diagnostic work, a patient's symptoms are fed into a computer which has built a huge data base against which the symptoms can be compared. A standard application would be to ask the computer to list the variety of diseases or systemic problems associated, through past medical experience, with these symptoms. An expert system, however, can go beyond this and actually create new pathological theories to explain the symptoms. Through telecommunications, then, a doctor in the most remote part of the world can benefit not only from the thinking and prior experiences of some of the most preeminent minds in medicine, but from the "thinking" of a powerful expert system. The excitement of this technology for education is to apply that model to individualized program planning for students. The teacher could feed basic data about a student's skill levels and past educational development into the computer and then receive from the expert system some possible diagnoses of learning styles and prescriptions for the most appropriate educational programming. This could be, finally, a harbinger of truly individualized approaches to student learning.

The technology of the future is already here; we need to brush away our Luddite tendencies, and embrace and use these immense resources which are waiting for our creativity and enthusiasm. In 1907, U. S. President Theodore Roosevelt sent a message to our Congress which included this sentence: "To waste, to destroy, our natural resources, to skin and exhaust the land instead of using it so as to increase its usefulness, will result in undermining in the days of our children, the very prosperity which we ought, by right, to hand down to them, amplified and developed." The resource of technology is here, waiting to be used. We need to increase its usefulness in the days of our children so that the quality of life in their world will be amplified and developed. To paraphrase an American comicstrip, Pogo, "We have seen the future and it is us!"

CAMPUS COMPUTING STRATEGIES FOR THE 1990'S

A P Broadaway*

ABSTRACT

Creation, storage, retrieval, processing, use and dissemination of information are at the core of academic effort. Any system that amplifies human cognitive capabilities has tremendous consequences, and the capacity to process abstract symbols in ways that enable each person to develop to their maximum potential is a profound development. This work seeks to identify the major topics that must be raised, discussed, and answered to ensure academic institutions achieve their objectives in an appropriate and effective manner.

The challenge implicit within this work is to face the future, and fully integrate a computer based environment into the totality of education with all its diverse needs, in the most effective way.

INTRODUCTION

There are several inter-related concepts that determine the strategy for campus computing in the next decade. The primary factors are the learning process, technology change and the source of capital funding. The impact of computers on curriculum design and content, and the theories of learning and how computers can be used to individualise learning i.e. adapting to the learning mechanism of the student, are both very important. The different types of students, the present state of computer based learning and subsequent enhancement with artificial intelligent techniques are also relevant. Finally, the use of the computer as a tool and the social consequences of implementing a plan based on the arguments made must be considered.

THE CURRICULUM

Changes in society, in political perspective, the economy, in technology etc. all effect views about the content of education and whether what is taught should be changed. Different educational ideologies give rise to different types of curriculum theory, and many organisations have views on the content of the curriculum. From the theory comes the model of curriculum design, and we can consider the influence of computers on the design models. It is seen that the integration of computers and computer technology is necessary across all academic disciplines. As the curriculum changes, so does the need for appropriate and adequate staff development.

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LEARNING

By studying the mental, physical, social and emotional behaviour of people, those factors that affect the quality and quantity of learning can be ascertained. Different theories of learning can then be established, along with associated learning styles. In order to make computer based software more relevant and meaningful, it must take account of the issues raised and results found. The design of a CAL frame will incorporate certain points, but it will only be by the application of artificial intelligent techniques that significant appropriate benefit will be gained.

COMPUTER DEVELOPMENTS

From the early 1940's the rate of change in electronic technology has been rapid, with one application, the computer, being a most influential invention of the twentieth century. The convergence of many electromagnetic developments has given rise to the discipline known as information technology. For computers specifically, changes in both hardware and software have been dramatic as has the manufacturing techniques. To meet the needs and demands of an academic institution it is necessary for full account to be taken of the dynamic nature of the technology involved.

TYPE OF STUDENT

Another essential thread towards the strategy is the concept that different students from different age profiles have different needs. Additionally the need of special students i.e. different from the "normal" must be incorporated. Children, youths and adults have different learning styles and reasons for learning; special students are found on both sides of the standard.

COMPUTER AIDED LEARNING

Following on from early programmed learning and teaching machines are most of the present day CAL techniques which are commonly based on "Skinner" type psychology. The impact of the microcomputer has given a resurgence to CAL development, with many different styles of CAL being determined. It will be necessary to incorporate the earlier presented ideas within computer aided learning software using artificially intelligent techniques to achieve a realistic solution. The answer to the question "what is good educational software?" is yet to be found.

GOVERNMENT SCHEMES

The existence of many schemes and organisations have had significant impact on the use of computers in education. These range from the Microelectronics Application Programme (1978), the Microelectronics Education Programme (1980), Education Support Grants (1984), the Council for Educational Technology (1973), the Manpower Services Commission (1981), the Alvey Committee (1982) etc.

COMPUTERS AS A TOOL

The computer by being educationally neutral has by appropriate choice of software and techniques been used to support different educational philosophies. The emancipatory mode - computer as a tool to reduce tedious workload - contrasts with the modes where the computer is a focus. As a tool, the thread of activity is independent of the computer even though it is extensively used.

IMPLEMENTATION OF A STRATEGY

Several goals exist that provide direction in the planning of the provision of a computer service. The primary goal is to achieve a computer literate faculty, administration and student body: specifically, individuals who understand from actual experience how the computer can be used to assist in the management and discovery of knowledge. Another important one is that the system must always work. It is not easy to produce a specification of requirements against which our strategy can be determined as we have seen that a myriad of related concepts must be considered. The number of students and types of course delivery mechanism are changing as is the subject balance between disciplines. What is certain is that historic utilisation figures cannot be used as a measure of need when they, in reality, reflect only the maximum supply available in terms of available facilities at that time.

Accordingly a model that is student led is an alternative, and this is compatible with the present methodology employed to allocate recurrent base estimate funding to an institution. The number, the type, and the computing needs from a particular discipline can be used to produce an estimate of demand. The concept of an information grid or computing utility arises to meet the various conflicting demands. It must allow for processor intensive applications, for networking and for expensive peripherals to be shared.

ROLE OF COMPUTER SERVICES

Implicit within the implementation of the strategy will be a multitude of tasks that require co-ordination, planning and operating.

The dynamics of the situation require expertise related both to the technology and the user's specific applications needs. This means flexibility and the employment of high quality staff to ensure a throughly efficient and reliable service.

THE FUTURE

Optical computers (6th Generation), Bio computers (7th Generation), artificial intelligence, in-expert systems, visual programming etc. are all techniques that require attention and must be thought about.

CONCLUSION

The impact of computers on education is widespread and total as we move towards a future when computers will comprise the dominant delivery system in education for almost all levels in most subject areas.

By efficiently linking the needs of education with the abilities of technology, our campus computing strategy will meet the needs of students and the objectives of an academic institution.

As we approach the 21st Century, the assumptions and ideologies - about the nature of man, the distribution of power and wealth, the stability of knowledge and technology etc. - are all being challenged and we must be able to ensure each individual can have the opportunities to ensure they can effectively contribute to the debate about the future of society.

As a final comment, what is not fully defined in this work is the cost and source of funding of implementing the strategy as determined; the question to be answered really though is what is the cost of not implementing such a scheme?

BEYOND TEXT: a working (prototype) design for the Storage and Retrieval of Text and Digital Images of Teaching Materials and Courseware on Optical Disks.

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ABSTRACT

A working system is described that provides for the storage of a wide range of teaching materials of both text and non text forms whether or not available in computer readable form. The free text retrieval system enables the learner to search libraries of such materials that can be read from the screen or taken away in the form of hard copy. The use of Optical disk as the delivery medium provides an efficient and cost-effective vehicle for disseminating existing and new materials.

INTRODUCTION and DESIGN GOALS

Classical (structured) bibliographic databases provide for a range of search requirements for users. Our interest stems from seeking to provide such a resource for a wide range of teaching materials. Thus it is required that teaching materials can be accessed, searched and selectively retrieved for display on a computer screen or printed. This achieves two aims: a) the efficient and cost-effective re-publication/distribution of existing teaching materials and b) an efficient system for the learner who can search and selectively retrieve only what he/she requires. Teaching material could be in any form including teaching manuals, notes, or hand-outs containing diagrams as well as text. Some would be already in computer readable form (e.g. teaching notes that had been prepared using a word-processor). Existing material can be scanned using an OCR (Optical Character Reader) to convert to computer readable form or held as a digital image.

CONVENTIONAL DATABASE SYSTEMS

It is well known that there are a large number of database systems and packages in the market place that seek to harness the power of the modern microcomputer and provide for the manipulation of stored materials. In spite of this apparent over provision, they virtually all fail for teaching materials because they are designed to handle STRUCTURED numerical and/or text based material and that the material be composed in a form that meets various requirements of the particular database system. This is because Database design has been traditionally concerned with the structuring of records into fields (usually fixed length) together with a number of support processes to retrieve data by the use of record keys to generate reports. Updating is achieved through various means which often require overlay and restructuring or reorganising index and data files. Furthermore, this design philosophy has evolved in an environment where concern for the efficient use of limited backing storage and the economic use of processor time was paramount. In addition, it is not always realised that the inherent characteristics of magnetic disk based systems are embedded in the design of database management system software and that such systems do not transfer efficiently to microcomputer based systems especially those configured to support optical storage.

A FREE TEXT RETRIEVAL SYSTEM

Our earlier work concerned with text retrieval for lawyers and law librarians led to the development of a free-text retrieval system. In this system, any document can be stored and then indexed. Every word is indexed (other than high frequency trivial words in a so called STOP-LIST). The indexes provide the means whereby users can search a range of such documents. This has been extended to the system for manipulating teaching materials. The diagram shows in schematic form, the FIVE main files associated with each library. A library is defined here as a collection of (related) documents. The original document (together with the associated images) are indexed by the software to explode the source data to these FIVE files. Each different (text) word effectively forms the head of a system of pointers listing each of the occurrences of that word. An occurrence is defined as a record of:

- the document in which the word occurred
- the line on which the word occurred

- the word count from the start of the document
- the tagged field (if any) of which the word formed part

The above parameters allow simple BOOLEAN intersection, union and negation at the document level, word adjacency queries within and across documents and fielded restrictions. Final display of any successful selection is aided by the line count to give the user an instant highlighted contextual display. Comparative tests with cache and non-cache systems shows that final performance is likely to be processor rather than disk access bound.

In developing a system for the ubiquitous modern microcomputer, the previous constraints, limitations and influences from earlier generations of computer do not apply in the same way or to the same order. Thus for the microcomputer (with optical storage) we can consider storage as almost infinite and consumable with processor resource exceeding that available to most users of time-sharing systems. Our design is based upon the premise that RETRIEVAL should be simple to use and highly efficient (i.e. fast even from very large 200 megabyte applications). Such performance should also be achievable with optical storage having regard to the differing nature of CLV (constant linear velocity) recording as with CD-ROM.

TEACHING MATERIALS IN (or easily converted to) COMPUTER READABLE FORM

The above system thus provides a means whereby a range of teaching materials can be placed in one or more searchable 'libraries'. For convenience it may be of value to place the subject, author and titles of each document in separate fields. The user then has a complete range of search options available. Thus the learner can search for materials on a specific subject, or by an author, or by a title or searching the body of the material itself. In practice systems can be single user or multi-user if the library is provided on a network file server. The speed of generating the indexes when installing the system is sacrificed to ensure that this efficient retrieval performance can be realised. (indexing is typically 1 megabyte of source text per hour on an IBM AT). Similarly, the explosion in total storage required is prejudiced to achieve the performance aims. The degree of explosion depends on the nature of the source documents: thus 1 megabyte of closely spaced full lines of text may explode to 1.5 megabytes. Open text with very short lines may explode by a factor of 4 or 5. In practice, the indexing task which has only to be performed once when the system is set up does not detract from the final perception of performance by the user. Alternatively, the files produced can be compressed using well known techniques (e.g. Huffman code). By such means, the installed system can in fact be smaller than the original (i.e. uncompressed documents). Further work has led to the improvement and extension of the query language which is still fundamentally based upon commonly available on-line database search strategies and approaches.

Storage media space requirements depend on the degree of density of the teaching materials. The following gives some indication of the amounts that can be made available on different media:

medium	pages of A4
5.25in floppy disk	200
30 megabyte hard disk	15,000
optical disk	200,000

The recent adoption of the High Sierra format for CD-ROMs and the de facto WORM IBM PS/2 standard means that optical disks have matured as a practical and cost-effective medium for distributing and disseminating such materials.

TEACHING MATERIALS IN NON COMPUTER READABLE FORM.

Digital image files are representations of pictures produced by a scanner. Various formats have been proposed depending on usage requirements e.g. FAX formats for transmission, PCX formats for painting and drawing type packages. Utilities can be produced to convert from one format to another. By entering a small amount of classifying text (e.g. author, references,title, subject matter etc.) together with a reference number or name of the image file, searching may proceed on the principal fields. The learner can then display or print the image(s). For example, some 10 A4 pages of teaching material on

Music Staves stored as digital images MUSIC1 to MUSIC10. The learner may query anything on MUSIC and be given the title and brief description. To proceed further, the learner would request the display (or print) of each or all of the image files. Note that the image files can be 'pictures' of Music, or pictures of pictures or 'pictures' of text! - indeed anything. By extending the above definition of an occurrence to include a pointer reference to an image file we have achieved a mechanism for linking word occurrences with associated images. In practice, the PCX format for images is a good compromise between storage space and decompression speed. Image files consume enormous amounts of storage space. One page of A4 as a bit image file requires 1.8 megabytes although these are usually compressed to typically 50-200k. Until recently, the notion of using such large amounts of storage to disseminate teaching materials would have been totally impractical. On reflection it is now just as cheap to distribute 10 A4 pages of material on a 60p floppy disk as on photocopied paper. Optical disks now provide for the practical distribution of larger volumes. A 200 megabytes optical disk can easily hold 2000 pages of A4 text as images.

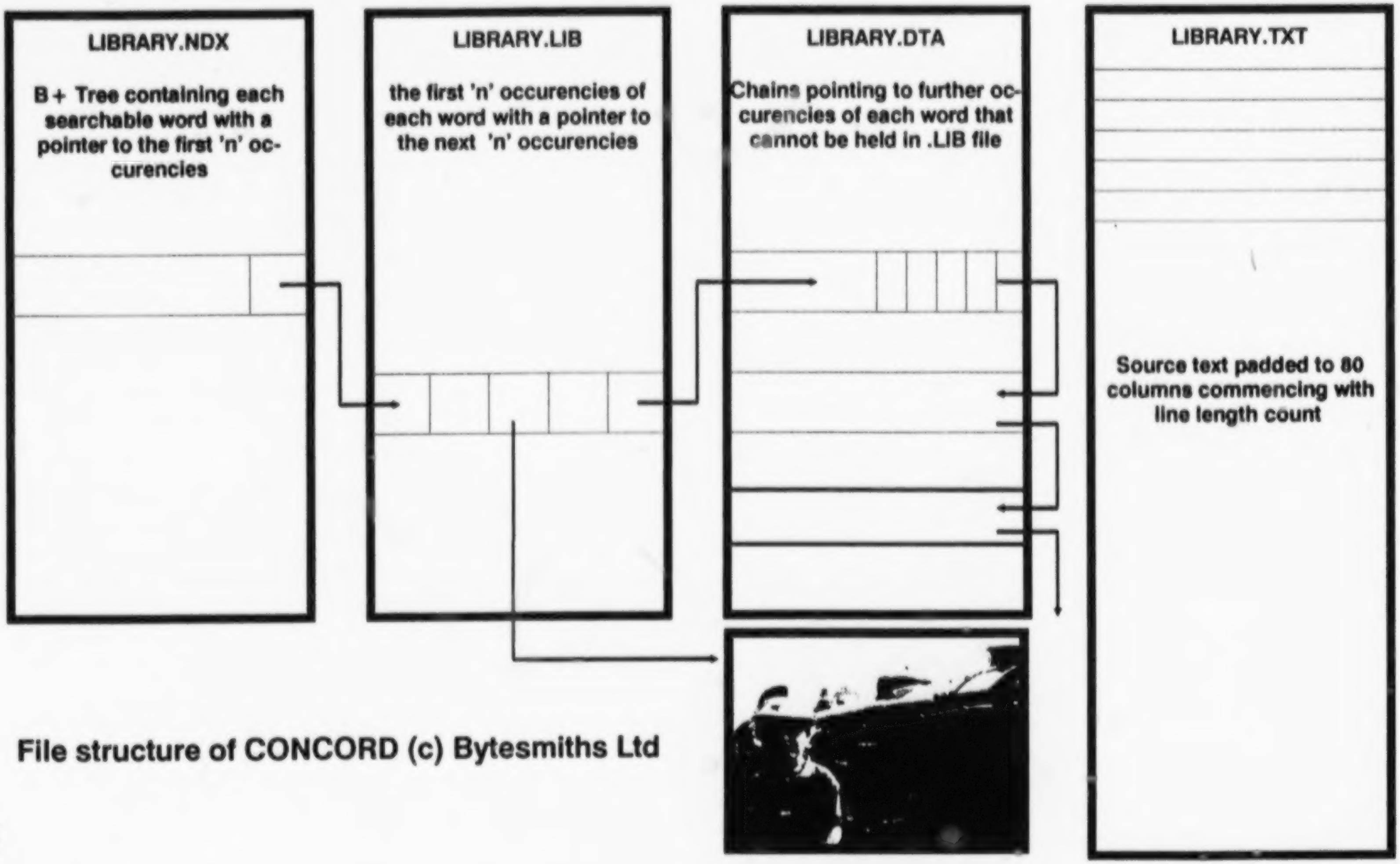
The size and quality of the image displayed on a computer screen depends on the screen resolution and there are many different standards. Whilst there are many specialist monitors to support special graphics applications, we are concerned with providing support for the PC family in order to achieve wide penetration. The IBM EGA standard of 640 by 348 pixels provides a readable display of a digital image representing one half of a page of A4 text and diagrams. There are also a proliferation of printer standards. Whilst a 300DPI laser printer is desirable, acceptable results can be produced by dot matrix printers. All types of printer take considerable time to print a digital image and delays of 10 minutes per page are not uncommon.

CONCLUSION

It has been possible to re-evaluate options for file design, file access and file processing decisions. Making choices that are sympathetic to the characteristics of current computing machinery produces an efficient retrieval system and demonstrates that such systems are practical. The imminent availability of the 80386 based systems with corresponding higher processor performance, screen resolution, multi-tasking, and operating system support for the full technology will have a dramatic effect on the expectation of the user in demanding rapid image based retrieval.

With an enormity of teaching material potentially available to the learner and concern for disseminating such in a cost efficient manner, the type of system described herein serves an important prototype.

The search software is available by special arrangement with bona fide educational establishments and researchers and also commercially from Bytesmiths Ltd 0279-815806 under the product name CONCORD.



LIBRARY.NDX

B + Tree containing each searchable word with a pointer to the first 'n' occurencies

LIBRARY.LIB

the first 'n' occurencies of each word with a pointer to the next 'n' occurencies

LIBRARY.DTA

Chains pointing to further occurencies of each word that cannot be held in .LIB file

LIBRARY.TXT

Source text padded to 80 columns commencing with line length count

LIBRARY.PIC

File structure of CONCORD (c) Bytesmiths Ltd

VIDEODISC BROWSING AND THE RETRIEVAL OF VISUAL RESOURCES

Sue Batley*

ABSTRACT

This research is concerned with the retrieval of visual, or pictorial information from a database on videodisc. Videodisc technology has made automated storage and retrieval of high quality visual information possible. A problem is that keyword access to pictorial information may be inappropriate if the type of information sought cannot be readily described in terms of such keywords. An experimental retrieval environment allows users to search for pictorial information in three ways - by serendipitous browsing, specific browsing, and keyword search. Preliminary findings indicate that the search strategies adopted by users are dependent upon two factors: the nature of the information need, and individual user characteristics.

INTRODUCTION

Information retrieval is the process of searching some collection of documents (using the term document in its widest sense) in order to identify those documents which will satisfy a particular information need. In traditional information retrieval systems each document is identified by a series of keywords, these keywords are used to construct a search statement. The degree to which users of an information retrieval system are able to recognize the exact nature of their information need, and the degree to which they can articulate it in a search statement, largely determine how successful the information system is in attempting to satisfy the need (Ref. 1).

Information databases are mostly concerned with verbal or text information which can be readily described by keywords. Two examples in the field of Education are the ECCTIS and NERIS databases. However, the ability to store and retrieve high quality visual information using videodiscs has introduced a new challenge.

One side of a videodisc and hold 54,000 still frame photographs - any one of which can be accessed very rapidly and displayed on a screen. Maximum retrieval time for any frame on the disc is approximately 2 seconds. The quality of each picture is very good - dependent on the quality of the original photograph and the television screen. Videodisc is a compact and very dense storage medium for pictorial information.

In the context of visual information retrieval the problem is that words cannot entirely represent an image - words cannot always describe and interpret pictures. Pictures are full of ambiguities and this means that each individual can impose his own interpretation on a picture, or an individual can impose different interpretations on a single picture depending on his interests at the time of viewing it.

One answer to the problems associated with the retrieval of visual information would be to offer an alternative to keyword access.

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The method which is being explored is one which exploits our pattern-recognition capabilities - browsing.

People browse, among other reasons, because their criteria of interest are not precisely defined, or are open-ended and subject to redefinition. Contrasted with the haphazard scanning of documents, browsing is often occasioned by a felt information need. The need may be ill-defined but nevertheless very real (Ref. 2). So browsing is sometimes a purely random, unstructured and undirected activity. Other times it is closely directed and structured, where although the final sources or media may not be known, the desired product or goal is clear (Ref. 3).

Browsing through a flow of videodisc images displayed on a screen will require different skills from those employed by browsers in a library environment, for example, but the basic concept is the same. The user does not attempt to go directly to a prespecified document, rather he scans available alternatives before selecting the document or documents which will satisfy his information need.

OUTLINE OF RESEARCH

The videodisc being used to examine visual information searching was created specifically for that purpose. The University of Aberdeen Library holds a collection of 40,000 photographs by a Victorian photographer called George Washington Wilson. 950 of these photographs were selected, arranged into broad subject groupings and put onto videodisc. The subject areas covered by this database are: Edinburgh, Aberdeen, Cathedrals, Castles, Rivers, Lochs, Mountains, and the Fishing Industry.

A program written in the authoring language Microtext provides access to the database. The program allows users to scan through images in the database using a joystick; step through groups of related photographs; or type in keyword descriptors. Summary files keep a record of each user's interaction with the database. Users may request text information about the photograph currently displayed on the screen and store a record of photographs they retrieve.

The joystick scan option allows for serendipitous browsing. Scanning speeds, which the user controls by manipulating the joystick, are: still frame; button press (on the handset) for next picture; 2 frames per second; 10 frames per second; and 15 frames per second - forward or reverse. These speeds were chosen to enable the user to scan quickly through sections of the database considered to be of minimal interest, and more slowly through sections of greater interest, with the option to examine frames in detail. The ability to browse in this way is obviously dependent upon the database being structured in a logical manner - i.e. the broad subject groupings.

The second type of search allows for specific browsing. Here the user selects a subject category from a menu and then steps through a group of related pictures. A database handling program is co-resident in the computer as an extension to Microtext. The user selects a category, the relevant data file is loaded into memory, and the computer searches for and displays the images for which records have been stored in the file.

The third type of search allows the user to type in keywords, taken from a keyword list, and step through a small group of pictures which share those descriptors. For example, EDINBURGH and CASTLE; LOCH and LOMOND; KIRKWALL and HARBOUR. This is obviously the most specific type of search and its use is dependent upon the user being able to formulate a verbal search statement.

This experimental environment has been created to discover how users search for pictorial information given the facility of browsing. Several factors will influence the search strategies adopted but only two have been identified as being of primary importance:

1. The nature of the information need, i.e. whether the information is required to satisfy a general or specific information need.
2. Individual users will adopt different patterns of use influenced by: experience with the interface, knowledge of the structure and scope of the database, personal preference.

THE EXPERIMENT

Each user was given eight tasks to perform - i.e. eight descriptions of objects or scenes for which appropriate images were to be retrieved. These tasks include two each of four visual information types:

1. Specific - The Scott Monument, Edinburgh; The River Dee.
2. General/Nameable - A Ruined Castle; A Tram.
3. General/Abstract - An Arch Shape; A Busy Street Scene.
4. General/Subjective - A Pretty Scene; A Scene that illustrates how Times Have Changed.

Before the user began the eight searches,each of the three search types was demonstrated and the user was asked to read a printed User Guide. The user then selected a search type and retrieved and stored an appropriate image for each of the eight requested items. At the end of the exercise the user was interviewed and a questionnaire completed.

PRELIMINARY FINDINGS

At the time of writing, 30 subjects have completed the experiment. It is expected that a total of 45-50 subjects will take part in this, the first of a series of experiments to examine visual information search strategies. However, from the subjects tested so far, a number of significantly consistent results have been obtained.

Table 1 shows the search types attempted by 30 users for each of the information types. Keyword searching was more likely to be used to retrieve specific information with a decline in use through the more general information types, while the opposite is true of the joystick scan search - which shows an increase in use as the specificity of the information need decreases. Use of the specific browsing function remains relatively constant and appears to be independent of information need. However, the relationship between use of keyword and joystick searching and information need is significant at the 0.01 level (χ^2=23.01 for df=3)

	Keyword	Specific	Joystick
Specific	37	14	21
General/Nameable	21	16	26
General/Abstract	11	20	32
General/Subjective	10	17	34

Table 1 Number of users attempting search types relative to information need.

The search strategies adopted are also dependent upon some

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characteristics of the user - users, when given the same task, will adopt different search strategies based on individual attributes and existing knowledge. Therefore, users will select different search types, search within different sections of the database, and search under different keywords. Prior expectations guide keyword searching to a great extent - in particular where keywords are used to retrieve the more general information types. For example, "A Busy Street Scene" will be specified as "Princes Street", etc.

Table 2 shows user opinions when questioned about preferred search type (n.b. several users felt unable to comment).

	Preferred	Liked Least	Only Search Type Used
Keyword	12	1	1
Specific	6	2	1
Joystick	3	9	5

Table 2 Preferred search type - user opinion.

Therefore, 13 users preferred keyword searching and 8 preferred joystick (assuming the preference of those who used only one search type). One point which may be noted from this is the number of subjects who liked joystick searching least. Many users complained of the lack of fine control with the joystick. So, even though users agreed with the principle of scanning, the device used for this function was seen to be inadequate.

From these preliminary findings it may be suggested that information need and individual user characteristics largely determine visual information search strategies. A complete analysis of the experimental results will follow but preliminary findings indicate that an area for further study is that of the user interface - to maximize the user-friendliness of the system and ascertain how this may influence the way in which users interact with the visual information database.

In conclusion, three guidelines for the design of visual information retrieval systems may be proposed:

1. Emphasis should be on providing a range of options for he user - to accommodate both narrowly defined and exploratory searching.
2. Care must be taken in the design of the user interface - the emphasis should be on ease of use - so that the system is accessible to both naive and expert users.
3. Some attempt should be made to individualise searching - by allowing users to select their own range of scanning speeds, choose between menu selection and typing in commands, choose which input devices to use, design a screen layout, etc.

ACKNOWLEDGEMENTS

The author would like to thank Dr Ray McAleese, Ph.D supervisor; the staff of Aberdeen University Library; and the subjects who took part in the experiments.

REFERENCES

1. F W Lancaster, Information Retrieval Systems (2nd ed. Wiley-Interscience, 1979) p 142.
2. C Hildreth, The Concept and Mechanics of Browsing in an Online Library Catalogue. In. Proceedings of the 3rd National Online Meeting, 1982. (Learned Information, 1982) p 181.
3. S Herner, Browsing. In. Encyclopaedia of Library and Information Science, vol.3. (Dekker, 1970) p 414.

CD/ROM AND VIDEODISC TECHNOLOGY IN TROPICAL MEDICINE

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ABSTRACT

A Level III interactive videodisc instructional program was combined with a CD/ROM player in order to integrate conventional information storage and retrieval with computer-assisted instruction. The videodisc visual data base was created by collecting an international assortment of 35MM slides and videotape linear segments. CD/ROM data consisted of a commercially available version of the National Library of Medicine MEDLINE. Structured learning modules were divided into Review and Self-Assessement sections, with access to CD/ROM MEDLINE available at all times. Recordkeeping is maintained throughout via an open DOS file for evaluation purposes.

INTRODUCTION

Education and training is of critical importance in tropical medicine control programs, particularly the training of paramedical workers. In many endemic countries, however, lack of an adequate communication and transportation infrastructure makes it difficult to organize and present tropical medicine training programs on a group basis and at regular intervals. Accordingly, it may be more practical in some areas to provide tropical medicine training materials in a self-contained, individualized format. Too, it would be helpful for medical specialists located in remote areas to have improved access to current scientific literature such as bibliographic citations and abstracts found in the National Library of Medicine data base, MEDLINE.

This is a report of an effort to combine microcomputer and optical laser videodisc and Compact Disc/Read Only Memory (CD/ROM) technology into a single tutorial and information retrieval system for use in tropical medicine control programs. The purpose of the study is to determine if contemporary communication technology can be utilized to create a low-cost, reliable, self-contained individualized study and information retrieval system for health care

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professionals working in areas without ready access to conventional continuing education and medical information resources.

METHOD

The first phase of the study consisted of creating a comprehensive visual data base on one (leprosy) of the six tropical diseases designated by the World Health Organization of special concern to developing coountries. This was done by gathering an international assortment of 850 thirty-five millimeter transparencies and twenty-two minutes of linear motion videotape segments, editing the material into a single one-inch C type broadcast-quality videotape, and mastering the videotape as a one-sided twelve-inch optical videodisc. A classification scheme consisting of twenty categories on various aspects of leprosy such as Epidemiology, Diagnosis, Histopathology, etc. was then established in order to categorize the videodisc material. Each category was subdivided into appropriate sections and each classification heading was preceded with a numeric identifier to facilitate computer programming. The following is an example of the Diagnosis category:

9.0 DIAGNOSIS

  9.1 General

    9.1.1 Indeterminate
    9.1.2 Tuberculoid (TT)
    9.1.3 Borderline Tuberculoid (BT)
    9.1.4 Borderline (BB)
    9.1.5 Borderline Lepromatous (BL)
    9.1.6 Lepromatous (LL)

  9.2 Differential diagnosis

  9.3 Techniques, methods

    9.3.1 Skin smear
    9.3.2 Biopsy
    9.3.3 Acid-fast staining
    9.3.4 Physical examination
    9.3.5 Sensitivity testing
    9.3.6 Lepromin testing

  9.4 Associated diseases

A twelve inch optical videodisc contains 54,000 tracks per side and each track is identified at the time of mastering with a five-digit frame number. This frame number was used to categorize each still and motion sequence in one or more of the twenty topic areas of the classification scheme. A text description of each visual was created for display on the computer screen and an appropriate branching structure was developed for immediate (one to three seconds) access to any particular still or linear motion visual in the data base. Computer programming was done by the author in PC/PILOT (Version 4.0), an authoring language developed specifically for use in educational applications.

TOPIC TUTORIALS

With mastering of the optical videodisc and appropriate categorization for microcomputer access to its contents, it was then possible to begin work on the design and development of single topic tutorials. Initially, three lessons were created in the areas of Epidemiology, Diagnosis, and Histopathology. Each lesson is divided into two main sections: Review and Self-Assessment. Review consists entirely of descriptive text and visual information and is subdivided into discrete categories for immediate access by the user. Self-Assessment consists of multiple-choice and keyword questions about various aspects within the particular category; most questions utilize an accompanying videodisc image although not necessarily. A score is provided to the user upon exiting the Self-Assessment section and, if desired, an open-ended file can be maintained for instructor review of all learner input. Immediate feedback regarding the correctness of the answer is provided for each question. The entire tutorial is error-protected and an escape subroutine is provided throughout for learner egress or alternate branching.

INFORMATION RETRIEVAL SYSTEM

Conventionally, a distinction has existed between individualized instruction and information retrieval services. However, recent emergence of optical disc technology is blurring is distinction; that is, it is now feasible to integrate a data base search such as MEDLINE right within a specific computer-assisted instruction (CAI) module. Thus, if a learner undertaking a tutorial on a particular topic became curious about current literature on the topic, he or she could go immediately to the MEDLINE data base on the topic. Conversely, if the learner is exploring recent bibliographic citations on a particular topic and decides that he or she would like to know more about the topic, or to see some still or motion visuals on the topic, such immediate access would be possible. In short, microcomputer and laser disc technology has now created an entirely new opportunity for creating individualized teaching/learning systems.

Specifically, the preliminary study utilized the CR/ROM version of the National Library of Medicine MEDLINE published by Cambridge Scientific Abstracts, Inc. consisting of 296,238 bibliographic citations entered for the period January-September, 1986. The self-study program, itself written in PC/PILOT, uses the search software provided by the CD/ROM publisher and integrates CD/ROM merely by making an external DOS (Disc Operating System) call via a machine language subroutine provided by the Advanced Features Library of PC/PILOT. Upon completion of the CD/ROM search activity, the learner is returned to the point of departure within the original PC/PILOT program. The transition from one software base to the other is very fast and, for all practical purposes, transparent to the user.

DISCUSSION

The six tropical diseases identified by the World Health Organization as of special significance to developing countries affect literally hundreds of millions of persons, causing millions of deaths each year. To combat these diseases effectively, a major international public health effort will be needed, particularly in the training of paramedical personnel. Emerging educational technology such as optical videodisc, CD/ROM, and microcomputer-aided instruction is providing a powerful base upon which to develop a wholly new approach to medical education and training. There is no reason to assume that such technology cannot be effectively utilized in developing countries; indeed, in some respects use of this technology is actually more appropriate in developing countries where postal services, land transportation, telecommunications, etc. are limited or absent altogether. Accordingly, it would appear only reasonable to explore the possibilities inherent in the use of contemporary educational technology as a means to improve education and training in tropical medicine, thereby providing for betterment of public health in many areas of the world today.

THE COGNITIVE EFFECT OF INFORMATION TECHNOLOGY ON THE LEARNING OF MATHS

E. A. MURPHY

ABSTRACT

A computer oriented mathematics syllabus was taught to an unstreamed class of eleven/twelve year old boys for two academic years. The remaining eleven/twelve year olds, in two unstreamed classes, acted as control groups, and pursued the conventional syllabus. The experimental group accumulated in excess of 3,000 hours 'hands-on' computing experience.

Krutetskii (ref 1) and Cregan (ref 2) had confirmed that metacognitive mathematical skills were either absent or weakly developed in average ability students. Furthermore the eight psychological traits (metacognitive skills) identified by Krutetskii identifed mathmatically able students. Cregan (ref 2) students with standard scores in the third quartile of the Drumcondra Level 111 A Maths Test (ref 3) were classified as average ability students.

In Octover 1984 there were 20 students in the experimental group and 26 in the control group who had scores within this third quartile range. The Drumcondra test was re-administered in June 1986 and the scores standardised using the appropriate norms Null Hypothesis: The 1986 standardised scores of the average ability students did not differ significantly from their 1984 standardised scores. A highly significant difference (P 01) difference occurred within the experimental group. The control provided no evidence to reject the hypothesis. The two groups also differed significantly on Krutetskii's tests (Administered in December 1986 and January/February 1987).

RESEARCH MODEL OF INTELLIGENCE

Skemp (ref. 4) proposed a director system model of mathematical intelligence. There are three components of this model; (1) Operators; (2) First Order Systems (3) Second Order Systems. In this study operators are defined as the number bonds and facts of addition etc. The first order director systems are defined as the mathematical activity as described in the index of any maths text book. The second order (metacognitive skills) are those identified by Krutetskii (ref 1). These second order skills do not directly affect the solution of a specific problem but greatly influence the student's capacity to solve the problem. These second order metacognitive skills directly influence the rate of mathematical development of the student and the level of achievement attained by the pupil. The first order activity takes place in the maths environment and is observable, the second order activity is the quality of the student's thinking and is inaccessible and unobservable.

Eight metacognitive skills were identified by Krutetskii (ref 1) as suffficient conditions for mathematical ability. (1) The ability to analyse and synthesize and to fuse the solution into a single analytic-sysnthetic activity (2) The capacity to retrace one's mental steps. (3) Facility with variables, (4) Ability to transform a problem, to manipulate data, to reduce the unkown to the known,

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(5) Dynamic spatial concepts (6) Ability to visualize, to imagine, to estimate etc.

RESEARCH PLAN

The computer oriented mathematics activity was directed specifically towards the formation of the second order systems. The ordinary mathematics classes were devoted to the development of the Operators and the first order systems. The total time devoted to mathematics by both the control and the experimental groups was approximately the same. The first 40 hours computer related activity was classified as Computer Science. The remaining time spent on computer related activity by the experimental group was classified as mathematical activity.

MODEL OF LEARNING

The study implemented Bruner's (ref 5) four major features of instruction theory

(a) Motivation

This study used the 'elemental' approach to the teaching of computer science. The commands were first introduced in physical education classes. The teacher assumed the role of the computer and students physically reacted to the commands. Pairs of boys interchange roles as computer and turtle. One boy is blindfolded the other calls out the instruction the student who is blindfolded must visualize the shape traversed by the commands.

Procedures were taught in the art and craft classes. Cut out a design on a potato - that is your procedure, your stored sequence of instructions. Reproduce your design in red at screen (graph paper) location 20, 20 etc. Similarly the concepts of recursion and function were introduced in a playful non-computing environment. Recursion - the magic witch offers the pupil four wishes, on the third wish the pupil requests four further wishes on the 7th wish four further wishes etc.

(b) Assisting the student acquire the structure of the knowledge. Bruner (ref 5) stated that knowledge can be mastered at one of three levels; enactive, iconic and symbolic. Furthermore good structure should help the child to simplify and interrelate details, and deduce new ideas from previously acquired ones. Finally Bruner looked upon transfer as the tranferring of 'principles and attitudes'. Enactive knowledge was catered for in the physical activities of the physical education and the art/craft activities. Papert's (ref 6) screen turtle provided visual reinforcement for Bruner's iconic knowledge to take place.

TRANSFER OF PRINCIPLES

The metacognitive and conventional mathematical skills were formed relatively independently in academic terms one through four. In terms 5 and 6 the two strata were fused into one mathematical activity. This was achieved by altering Logo to become a declarative language. All the variables a student needed were therefore declared at the beginning of a program. The students used boxes as their physical referents for variables. A typical project was to write a Logo program to calculate the area of any room

Phase 1 ABSTRACTION - How many boxes will I need? What operations will I have to perform on the boxes?

Phase 11 GENERALIZATION - Student must declare the boxes

Phase 111 EXECUTION - write the program

Step 1 - Deposit Length in Box one; Step 11 - Deposit width in Box two

Step 111 - Multiply Box One by Box Two and deposit the result in Box

Three; Step IV Print Box Three. Through the integration of the Logo language and rotation with the conventional arithmetic programme it was hoped that the general principles of abstraction, reversibility, flexibility etc would also transfer. There was, therefore, a very systematic transfer sequence to the use of the computer throughout the study.

Phase one: Computing concepts introduced inside the classroom and experienced outside the classroom in Physical Education classes: Phase 2 Transfer of the concepts back into classroom via, art and craft, elementary programs, discussions and lessons on computer science; Phase 3 Transfer of principles to external computer bureaux - 9 computers; Phase 4 Beginning of term four introduction of colour monitor into classroom. Transfer of computer bureaux work into classroom. Phase 5 Academic terms 5 and 6 transfer of Logo related activities into traditional maths environment. Phase 6 (hopefully). Transfer of Krutetskii's metacognitive skills from the computing to the convenional mathematical environment.

(c) A plan for sequencing the activities.

The sequence of programming activities corresponded to those of the Brookline reports (ref 6). Procedures, Editor, Recursion, Functions and Variables Subprocedures, Conditionals, Interactive-recursive Procedures and programs in Logo based on conventional mathematical activity (NOT INCLUDED IN THE BROOKLINE SEQUENCE). The sequence of mathematical/programming activities pertained exclusively to the development of a second order director system within the student.

ANALYSIS AND SYNTHESIS

Throughout the two years the experimental group were encouraged to adopt a planning strategy in formulating their programs. They were encouraged to decompose the program into a planned sequence of sub goals. To identify an anchor point and to synthesize the programming solution around this anchor point, The object of these excerises was to help the student form an 'integrally dismembered' image of the problem.

REVERSIBILITY

Unplanned A central, but unpredictable, element of the programming activities is the occurence of programming 'bugs'. The students were encouraged to trace the error back to its logical beginning.

Planned Reversibility Negation and compensation within fixed and moving frames of reference. The need for state transparency was emphasized.

Negation To make an image appear, disappear

Compensation In order to repeat a sequence of the same design the fixed anchor of the synthetic solution must be place in a moving frame of reference.

Negation and compensation combined Erase and reproduce a design within a moving frame of reference e.g. write a procedure showing a rocket in orbit around the room.

GENERALIZATION AND FACILITY WITH VARIABLES

The students were encouraged to (1) Recognize a pattern, (2) Utilize the pattern, (3) Extend the pattern and finally, (4) Generalize the pattern. The sequence will be repeated several times using different designs (1) A lorry/car, (2) a house, (3) a boat, (4) TV set, (5) A Flower (6) A fish (7) Dog etc. The designs were used within the following sequence of programming activities

(1) Procedure which repeated the design three times (2) Different sizes of the same design (3) A procedure involving variables which reproduced the design to any specified size (4) A recursive procedure displaying the design (a) Increasing (b) Decreasing in size (5) A recursive procedure similar to (4) with conditional stops (6) A recursive procedure similar to (5) with different colours in the patterns.

A PLAN FOR REINFORCEMENT

The actual instruction strategy followed Underhill's (ref 7) teach, assess, enrich or reteach in smaller groups. An integral element of the study was peer group teaching. Individual instruction of the weaker pupils was often carried out by pupils at the enrichment stage.

ASSESSMENT OF THE STUDY

Ireland has reached the peak of its school going population. For the students in this study, both control and experimental, there was a short fall of thirty percent in the number of 'suitable' second level places. There is considerable pressure on pupils and teachers to secure a place in these schools. Mathematics is a key element of these entrance tests and where students overall scores tie their mathematics score determines the rank. Many schools grade their intake on the basis of these examinations. Both control groups were taught by two very experienced teacheres and certainly when the Drumcondra test was re-administered in June 1986 both control groups were exceedingly well versed in the traditional maths syllabus.

STATISTICAL ANALYSIS

(1) The experimental group was representative of Irish fifth class children. The 1984 standardised scores of the experimental group showed no evidence to reject the hypothesis that their scores did not conform to the Drumcondra norms.

(2) A runs test confirmed that in October 1984 average ability was randomly divided between the control and experimental groups.

(3) Wilcoxon Signed Rank Test on the difference between the two sets of standardised scores (Average Ability Students only)

Ho

Experimental group one tailed probability less than .002 highly significant rejection of Ho. Control group. Z score 1.00 no evidence to reject Ho one tailed probability greater than .16. Nine quantitative tests from Krutetskii (ref 1) were individually administered to the 46 average ability studnets. Each student's total score on these 9 tests was calculated. It is difficult to interpret mathematically, precisely what this total score represents. Itisperhaps, a measurement of a student's total mathematical ability as quantified by Krutetskii's arithmetic tests. A runs test on this total maths score revealed just 9 runs, the Z score of 3.9 (P .0001) indicates a very strong tendency for the population to cluster. A more detailed analysis revealed that the first 13 places in order of merit belonged to the experimental group while the control group provided the last ten places. On the evidence of the runs test of randomness the population has changed significantly between Oct '84 and June 1986.

REFERENCES

(1) V KRUTETSKII The psychology of mathematical abilities in schoolchildren (Chicago Press 1976)

(2) E CREGAN A study of the defining characteristics of mathematical giftedness. (Unpublished University College Cork)

(3) DRUMCONDRA Attainment tests, Research Centre, Dublin 9, Ireland

(4) RR SKEMP Intelligence learning and action (Wiley: New York 1979)

(5) J BRUNER The process of education (Vintage Books: New York 1963)

(6) S PAPERT Mindstorms (Basic Books 1980)

(7) BROOKLINE REPORTS 1, 11, 111 Logo Memoranda 49,53 and 54. M.I.T., Cambridge, M.A.

MIXED INSTRUCTIONAL STRATEGIES

M. Pengelly*

ABSTRACT

This paper presents a conceptual framework for an intelligent tutoring system that will support an eclectic approach to tutoring. How a system conforming to this framework would adapt to individual student's learning requirements and technological innovation is indicated. The framework is discussed in the context of previous models of tutoring systems.

INTRODUCTION

Anyone who has tried to teach in a conscious manner knows that the pursuance of a single instructional technique is usually insufficient to enable effective learning. This is borne out by observations of classroom teachers whose actions in helping students learn cannot be interpreted within a single teaching strategy or even a single educational philosophy. A cursory analysis shows that teachers' activities are not consistent with just a single cognitive model of their students. Sometimes teachers appear to view their students as adaptive mechanisms, using instructional techniques drawn from a Behaviourist school, and sometimes as complex problem solvers whose abilities they encourage by means of Socratic dialogue.

Despite this general awareness of the need for diversity of approach, few computer based instructional systems exhibit this quality, or at least to any degree approaching that of their human counterparts. This may be attributed not only to hardware and resource constraints but also to the emphasis that has been placed on aspects of tutoring other than the pedagogical decisions, such as knowledge representation and problem solving, because of their wider applicability in other areas of Artificial Intelligence (AI). As technological innovation increases the number of learning environments, the tutoring decisions become more difficult. In consequence it would seem important to place emphasis on these decisions, which form part of the pedagogical processes in an Intelligent Tutoring System (ITS), so that technology may be employed more effectively to overcome students' learning difficulties.

Since many of the new technologies are computer based it is sensible to ensure that future computer based instructional systems can utilise these innovations. This paper presents a framework that should enable this without extensions as more technologies are added. This same framework is also suitable for a mixed strategy approach to tutoring using conventional computer based learning environments.

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THE PROBLEM

Both novel hardware and software technologies are candidates for inclusion in future ITSs. The software technologies that are likely inclusions are based on both conventional programming techniques and those more recent developments from the areas of AI and cognitive science. The former provide the learning environments that are now familiar in the classroom through the advent of personal computers, such as historical data-bases, simulations, and games; the latter developments provide such learning environments as monitored problem solving, micro-worlds, and articulate experts. The effectiveness of these technologies has been demonstrated, but mostly in isolated instances and not within the global context of a complete course.

The software advances have been underpinned by advances in computer hardware; but other hardware, interactive video discs and advanced communications technology, is opening up new avenues of learning, although the older technologies, perhaps in revised form, should not be excluded, for instance voice recording and play-back.

For the experienced teacher when to encourage the use of any particular learning environment appears to be based on heuristics that have been built up through trial and error and the advice of other teachers. Although the rules that are used may not be readily accessible, especially when observed in a classroom, the principles can usually be articulated. These principles may seem to be an adequate foundation for the pedagogical decision-making processes in computer based tutoring systems, but I believe that two problems may arise in basing the decision-making on these principles. Firstly, there is little evidence that the principles that apply to teaching in a classroom or even to one-on-one tutoring will hold true when transferred to a computer based environment. Secondly, little experience has been gained with the inclusion of new technologies into teaching strategies in the traditional environment, so that when it would be appropriate to involve a student with them is unknown.

THE FRAMEWORK

A conceptual framework on which an ITS might be built that has the ability to match its instructional strategies to a student's learning requirements and adapt to new technologies is illustrated in Fig.1. This presents the bare bones of a tutoring process in order that the feedback that enables the system to employ a mixed strategy is evident.

The framework is based on a process of learning that is a progression through a number of states of understanding; with instruction as the means of guiding the student through these states in a way that depends on educational aims and philosophies. In order to make headway practically, the educational aims will be restricted to training environments, where a particular industrial or commercial skill needs to be learned, and academic environments where sufficient understanding on the part of the student is to be achieved to satisfy traditional examination requirements: the age level is 16+.

The PLANNER chooses a sequence of activities with which a student is to be involved based on the initial state of the student, sm_i, and some state that is considered desirable, sm_f; except for the first activity the sequence need only be a skeletal plan. The PLANNER also predicts the state of the student after the activity, sm_p. A student monitored as being in state sm_i interacts with the system via the PLAN EXECUTOR and is monitored after the first activity as being in the state sm_o. Although this procedure is described as though it were deterministic, in reality neither the assessment nor the prediction of the student states can be made with certainty. If sm_o and sm_p correlate to a sufficient degree then sm_o becomes sm_i and the next preplanned activity is refined and invoked. Should sm_o and sm_p not correlate well, this indicates that the next pre-planned activity may not be ideal and the planning processes will be reactivated and a new plan generated on the basis of a new sm_i, which is the sm_o of the last activity.

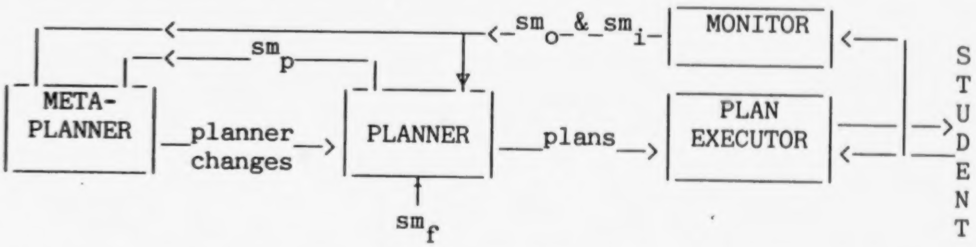

FIG. 1 Conceptual Framework for ITS Using Mixed Instructional Strategies

Although the planning is accomplished dynamically by mixing the instructional strategies to the perceived state of the student, for similar student states the same plan will be produced even if it has been unsuccessful in the past. This situation will occur if the principles used to drive the planning prove to be wrong or ad-hoc decisions have been made on the introduction of new technology. To overcome these problems a meta-level planning activity must take place that changes the procedure by which the activities are chosen. If notice of the failure is given to the META-PLANNER in the form sm_i and corresponding sm_p then a history of unsuccessful plans can be built up for individual students and, importantly, across students. When sufficient evidence has been accumulated that the planning process should be corrected then the rules can be revised and new ones introduced if required. There must be sufficient robustness in the system to prevent the revised rule set from generating wrong activities where before they were correct. This can be achieved by keeping a history of successfully paired sm_i's and sm_p's. The key element of this framework is the META-PLANNER and its history of student-system interactions which will effect changes to the PLANNER through learning about failure.

COMPARISON WITH OTHER FRAMEWORKS

The planning takes place at several levels; at one level decisions on the order of teaching topics within a subject are made; at another level the order of meeting the objectives within the topic must be decided, and at yet another level how those objectives are to be met, that is with what activities and what technologies will be used to implement those chosen activities. The planning may be looked at as means-ends analysis with the student state determining the prerequisites for a particular activity and technology and the predicted post-conditions providing the prerequisites for the next choice of activity.

This is similar to a scheme proposed by Peachey and McCalla (ref 1), although their prerequisites only cover understanding and misconceptions. They also work on certain knowledge about the understanding and misconceptions.

The concept of multi-level planning is also emphasised by Macmillan and Sleeman (ref 2). They see the planning process at four levels with control of the interaction also encompassed within the lowest level. They advocate and have demonstrated that a blackboard architecture is an appropriate AI technique for implementing such a system.

Within the framework proposed here elements of the more conventional approach to ITSs, a domain knowledge base, a student model, an interface module, and a teaching strategy module, are identifiable. Implicit in sm_f, the desired state of the student, is the knowledge base for the subject. The student's intermediate states, sm_o, are the equivalent of an overlay model of the student, with extensions representing student characteristics, such as strengths, weaknesses, preferences, and learning styles. The MONITOR and PLAN EXECUTOR make up the interface module which presents information to the student and monitors the student's response. The PLANNER in deciding on the next action and generating details to pass to the interface is in direct correspondence with a teaching strategy module.

SUMMARY

A framework has been proposed that allows a view of how two levels of adaptivity might be achieved in a computer based tutoring system. At one level the tutoring system would be adapting itself to its current perception of the student by dynamically planning instructional activities; and at another level it would be adapting itself, through experimentation, to revise poor planning procedures and incorporate new technologies. Both these levels contribute to the ability of the machine to exhibit a mixed strategy approach to instruction.

Confidence in the appropriateness of this framework is generated through being able to project earlier models of tutoring onto it. There is evidence that current AI techniques will support an implementation.

ACKNOWLEDGEMENTS

I would like to thank my supervisor, Lindsey Ford, for his discussions and comments on this paper.

REFERENCES

1. Peachey, D. R. and McCalla, G. I. "Using planning techniques in intelligent tutoring systems." Int. J. Man-Machine Studies (1986) 24 , 77-98.

2. Macmillan, S. A. and Sleeman, D. H. "An architecture for a self-improving instructional planner for intelligent tutoring systems." Comput. Intell. (1987) 3 , 17-27.

COMPUTATIONAL PHYSICS - A NEW DISCIPLINE

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ABSTRACT

This paper is designed to show a general audience that science and, in this particular case, physics, is being enhanced in a dramatic way by the recognition that computational physics is a discipline in its own right.

In the Physics Department at Salford University, the Software Development Unit has been built up on the basis of a substantial award by the Computers in Teaching Initiative (CTI). This paper describes the work carried out by the Unit over the past two years to develop high quality software to teach computational physics. It also addresses the major issues that mould the effective introduction of computers and computational techniques to physics students. It emphasises the need to expose students to this new and vital discipline and to advertise it extensively so that a wide audience shall get a clear understanding of the advances being made.

INTRODUCTION: WHAT IS COMPUTATIONAL PHYSICS

For too many years the education of physicists has been limited by the necessity of restricting lecture room attention to stylistic examples and laboratory attention to low cost, limited exercises. It has always been the case that physics is a mainly quantitative science, requiring a strong mathematical infrastructure to sustain it. The experimental part of the training of a physicist arises from the need to obtain high quality data about our environment and such diverse phenomena as the turbulence and chaotic systems and the emission of light by a semiconductor (LED). The introduction of the computer into the lecture room and laboratory liberates us from the constraints of cost and stylistic approach and in turn permits us to train a new breed of physicists, namely computational physicists.

Computational physics (refs 1,2,3 and 4) is now widely accepted as a separate discipline in much the same way that theoretical and experimental physics are, and lies in between the two. Computational physics is allied to experimental physics since it is possible to simulate and so investigate realistic physical systems in an economic and safe fashion in a manner that would not otherwise be possible. It is linked to theoretical physics in that mathematical equations governing the behaviour of a system can be studied more fully without recourse to gross mathematical simplifications which limit the validity of the solutions.

An example of the power of computational techniques can be brought out by the study of something as basic as a simple pendulum. Physics students can very easily perform a mathematical analysis of the motion of the bob for small amplitude displacements. However, as soon as the initial displacement becomes large, the simple mathematical approximation breaks down. The situation is further complicated if damping and forcing are considered. Within a laboratory situation a pendulum can be studied with ease. However, for certain values of damping and forcing, the motion of the pendulum becomes apparently chaotic. This motion is non-deterministic only because the initial conditions cannot be exactly replicated. However, a computer simulation of the system can set the conditions exactly, and students can study with ease the behaviour of the bob outside the regions where an analytical solution applies.

Computers enable physicists to become simulators who can produce and use sophisticated

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software packages to investigate real problems. They may, for example, simulate the behaviour of pulses in real optical fibres, laser reflections from the atmosphere for weather prediction, the flow of liquids and gases around complicated objects such as aircraft, sewage and other effluent flow problems, electronic devices, sensor applications in chemical and medical fields and many other applications.

There is a well-defined need for computational physicists by industry, that has been perceived by the institutions for higher education. However, sixth-form students are still not aware of what computational physics really means and consequently few students are taking up the subject. The problem is that the subject is relatively new. Careers and science teachers are simply not in a position to advise their pupils about its marketability and to encourage A-level students to consider the possibility of undertaking such a course.

COMPUTATIONAL PHYSICS AT THE UNIVERSITY OF SALFORD

The Department of Pure and Applied Physics at the University of Salford has a long involvement with computational physics. In 1973 it introduced an innovative part-time Masters degree course which has been continuously sucessful ever since and has attracted students of a very high quality. In 1983 it initiated a computational physics option as part of the Science Faculty's Joint Honours degree programme, and it has recently established a B.Sc. honours degree in "Applied and Computational Physics".

THE SOFTWARE DEVELOPMENT UNIT

The Department has a proven track record in producing physics based software at a variety of levels. It has been the recipient of a number of awards and has published several books (refs 5,6 and 7). In 1986 the Software Development Unit in the Department was set up on the basis of an substantial award from the Computers in Teaching Initiative (CTI). Two of the most important apsects of the project have been the production of (ref 1):

- a significant set of software to teach physics and computational physics;
- a user-friendly interface.

The training of a computational physicist entails not merely trying to produce physicists who can tackle a problem computationally, but also educating students to use sophisticated simulation packages in an intelligent and productive manner. To run a simulation program in a sensible fashion is not a trivial exercise, and requires an understanding and appreciation of the physical system and its behaviour, as well as familiarity with running the software. Thus, one of the main aspects of the work carried out by the Software Development Unit has been to produce a significant set of software on a wide range of pertinent subjects such as quantum mechanics and hot electrons in semi-conductors, through to chaotic systems. (See Appendix A for a list of titles). All the programs are written in strict, standard FORTRAN77 and use GKS (Graphical Kernel System) for the graphics to achieve maximum portability and so aid distribution to other institutions.

A necessary end-product of the software development activity has been the production of a user-friendly interface and programming methodology. The programming methodology consists of an overall set of rules for the design of programs, plus a set of specific standard techniques for performing a number of commonly required tasks. These methods are implemented with the aid of a library (the user-interface) of carefully tailored utility routines to provide complex input/output and graphical facilities within programs in a very simple and elegant manner (ref 8).

It is intended that the use of these techniques along with the libraray by the students will allow the writing of programs that are well-structured, robust and user-friendly with the minimum of attention being required in order to implement these aspects. This should allow the student to concentrate on the physics content of the program, and to develop sound programming techniques. The library may be used to provide such facilities as error-handling and data range checking on input, online help facilities and sophisticated graphics, graph plotting and graphical input/output in a portable manner.

FACTORS INVOLVED IN SETTING UP A COMPUTATIONAL PHYSICS COURSE

A computational physics course is not just computing tacked onto physics in an ad hoc fashion, but is an integration of the computer and computational techniques into the physics curriculum as an investigative tool. It is necessary to link the introduction of numerical and computational methods with the analysis of tangible, difficult and realistic problems in physics. Students need to establish a valid method of approach to tackling a problem, which can be broadly broken down into five stages;

- specify a "real" problem to be solved;
- set up a model;
- formulate and write the algorithm and the program;
- interpret and validate the solution against available data;
- use the program to explain and predict the system under study.

It is not necessary to go through all these steps every time, however each should be discussed at some point. An integrated computational physics approach includes the modifying of existing software and even correcting errant programs. Both approaches can do much to aid the students' understanding of the underlying physics.

The training in computational physics naturally embraces the traditional areas of physics, although at Salford the emphasis is away from the very pure areas of cosmology, elementary particle physics and so on. Every student should be exposed to an exciting set of opportunities to become both a sophisticated end-user of simulation packages and a generator of computer code to probe into physics. The traditional laboratory periods at Salford University are spent in the Departmental Computing Laboratory where the students can use the University mainframe computer (PRIME 9955), BBC and IBM compatible microcomputers, and now the recently acquired Departmental Computer (μVax).

PROBLEMS

The introduction of computational physics to the general physics curriculum is, however, neither smooth nor easy. As is the case with any radical change there are a number of problems encountered:

- software limitations;
- hardware limitations;
- inertia within the lecturing staff.

The truly effective application of computers in the teaching of physics will require, and will itself result in, major changes both in the teaching of the subject, and in the content of the curriculum. In this respect, the computer can be regarded not just as another tool to be used within the existing physics teaching framework, but as a significant change agent in the development of physics teaching. There is, however, something of a "catch-22" situation in that, in order for computers to be applied effectively to the subject on a large scale, the curriculum needs to change in a manner that requires the existence of the type of good pedagogic software that would result from such an application. The work carried out by the Software Development Unit, and other CTI funded projects, has gone part of the way in addressing and tackling this problem.

It has certainly been our experience that our existing hardware has its limitations. The students at Salford University all have access to the university mainframe computer. When there are a lot of users on the system, students can experience very long turn around times, and are discouraged by the delay in calculations and in the production of graphical output.

However microcomputers are rapidly becoming more powerful with faster processing capabilities, and are now capable of supporting languages such as FORTRAN77 and GKS, as well as subsets of libraries of subroutines such the NAG numerical library. Thus the hardware constraints should be eased.

On a more basic level, it is undeniable that there is a certain amount of resistence from members of the lecturing staff unfamiliar with the new techniques and who are unwilling to implement the use of computers within the existing teaching framework. However computers are here to stay, and computational techniques are becoming important enough, both within academia and industry, to warrant the investment of precious time and effort.

REFERENCES

1. A D Boardman, G S Cooper, B W James, G J Keeler, J Swage, Comput. Educ. (special edition), Proc. CAL'87, Pergammon, (1987).
2. P H Borcherds, Phys. Educ., 21, 238 (1986).
3. S E Koonin, Computational Physics (Benjamin-Cummings, 1987).
4. T Hinton, Comput. & Education, 2, 71 (1978).
5. A D Boardman (Ed.), Physics Programs (Wiley, 1980).
6. B W James, G J Keeler, The Super-user's BBC micro book (Addison-Wesley, 1986).
7. G J Keeler (Ed.), Getting the most from your Apple II, IIe, IIc (Addison-Wesley, 1985).
8. Software Development Unit, "A Programming Methodology for the Development of FORTRAN77 CAL Simulation and Modelling Software for Physics", and accompanying IOLIB library available on request from the Software Development Unit, Department of Pure and Applied Physics, University of Salford, Salford M5 4WT.

APPENDIX A

1. Ray tracing and lens aberrations.
2. Attenuated total reflection analysis of surface polaritons.
3. Computer generated holograms.
4. Calculation of fields near permanent magnets.
5. Particle capture in high gradient magnetic separation.
6. Magnetisation in the crystal field system praseodymium.
7. Elastic waves in crysalline solids.
8. A computer assisted tutorial in time independent non-degenerate perturbation theory.
9. Simulation of phonon dispersion curves and density of states.
10. Electron energy bands in a one-dimensional periodic potential.
11. Computer simulation of hot electron behaviour in semiconductors using Monte-Carlo methods.
12. Modelling of thermal conductivity of unidirectional composite materials.
13. Computational study of diffraction by microcrystalline and amorphous bodies.
14. The driven, damped, simple pendulum.
15. Bifurcations and chaos.
16. The driven, damped, spherical pendulum.
17. Particle interactions.
18. The nonlinear optical ring cavity.
19. A study of a universal equation in chaotic systems.
20. A three-dimensional raytracing package.

INFORMATION TECHNOLOGIES: A STEP TOWARD MEETING EDUCATIONAL NEEDS IN TURKEY

M S McIsaac

This presentation will describe Distance Education in Turkey as it is presently implemented at Anadolu University in Eskisehir, where this author was a Fulbright scholar during the 1986-87 academic year. A short background of political and economic issues leading to the development of this particular Distance Education program will be presented. Present concerns and future directions of the program will be explored with special consideration given to the impact of rapidly emerging information technologies.

In order to understand the magnitude of such an educational undertaking, the political and economic reasons for the choice of Distance Education will be introduced. Turkey, a developing country, found itself in the midst of civil violence and political turmoil as recently as 1980. One response to the urgent need to provide increased educational opportunities was the development of a distance education program called Open Education at Anadolu University. The program, a mere 5 years old, is unique in its attempt to provide over 100,000 spaces for students enrolled in business and economics courses in higher education. The first four year curriculum will be described.

Present concerns of the Open Education program include the role of technologies in delivering instruction. The single television channel, which is government operated, has been the primary delivery system because of its cost effectiveness. However, this only provides a few hours a day to broadcast educational programs to more than 40 million viewers. The availability of large mainframe computers has made it possible to manage coursework and grading for the large number of students enrolled in the Open Education Program. However, the potential of computing has just begun to be explored. The lowering cost and increasing availability of information technologies, sattelites, microwaves, and portable computers have presented opportunities to explore new ways of providing information to a wider audience.

Future directions for Turkey's Open Education program include the use by faculty of the recently installed EARNNET network. This provides access for faculty who can be trained in the use of computers in order to share information and link classrooms across the globe. The potential of this information technology as well as the moral and ethical considerations of imported culture in a developing country will be explored. Finally, the potential for distance learning of new interactive and low cost computer interfaced technologies will be examined.

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COMMUNICATION BASED EDUCATION: OPEN LEARNING FOR THE CLASSROOM

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ABSTRACT

The integrated use of computers and telecommunications *in combination* or telematics, provides new opportunities for human conversations and,therefore, for learning. But new skills must be learned for using these new technologies if they are to be successful for more general learning. Communication Based Education is a new methodology offering an approach to curriculum which allows both teachers and students to experience their own learning through hands-on activities and interactions with others teachers and students around the world. Its theoretical base is Conversation Theory, a modern cybernetic theory of learning which deals with how we derive meaning from our communicative interactions.

INTRODUCTION

The philosophy and practice of communication based education derives from the praxis of open learning developed over the past twenty years within adult learning settings often involving learning at a distance. Open Learning is a philosophy of learning that is concerned with solving the practical problems of creating learning environments and opportunities for individuals to learn *where they are and as they are..* In particular, open learning is innovative, implying a rethinking of all aspects of the learning endeavour in order to support service to the individual person. The advent of world-wide telecommunications networks using computers has allowed the possibility for open learning to dissolve the walls of school classrooms and to truly enable individual classrooms to connect with each other and remote learning resources from where they are and as they are. This shift will enable the world to become the classroom and to truly make "distance a state of mind"(Ref.1). However, such activity will require development of the infrastructures to make these activities cost effective and to provide the philosophically based framework for pursuing the questions of how best to learn in this new "informational space". This paper will outline some of the pilot and demonstration projects which have led to the development of this new methodology. The projects described in this paper all derive from the authors' twenty years of experience in open learning, now being applied in the school setting.(Ref. 2)

THE SCHOOLS NETWORK

The Schools Network Pilot Project was conducted between March and June, 1987 and involved 35 schools and 70 teachers in schools throughout British Columbia. It was sponsored by the Knowledge Network with the 12 participating School Districts sharing in the cost. The project was contracted out to Open Systems Architects, a joint venture of Snowflake Communications Ltd. and Pacific Learning Systems who designed and implemented the entire project.

The project was designed to demonstrate an infrastructure which would involve students, teachers and administrators in learning how to use, apply and develop communication and information technologies. The focus was to explore communication based education applications in a number of subject areas through the use of both audio and computer conferencing and access to databases and electronic fieldtrips.

There were many unique features of this Pilot Project which distinguish it from other innovations. These include:
1. A clear directional strategy for managing innovation within the school environment and creating an opportunity for teachers to learn through doing.
2. The combination of a variety of telematic application projects within a supportive infrastructure to demonstrate how system wide change could be effected in a rapid and positive manner.
3. A strong theoretical framework based on Conversation Theory for integrating technology within the learning process
4. A unique "Valuation of Innovation" formative and summative assessment process intended to provide both feedback and feedforward to those who participated.

Teachers attended a one-day introduction to the project in which they learned how to "get on-line". Because of the immense distances between the schools even organizing this one-day workshop was difficult to accomplish. All other support was provided on-line and by telephone. Teachers were able to access the Canadian public packet switched network, Datapak, either directly or through iNet 2000, an 800 telephone access to the system. Both the University of British Columbia(UBC) and Simon Fraser University(SFU) offered free access to their computer conferencing system, *Forum, which was used as the coordinating framework for the project. Proprietary databases, Infoglobe from the Globe &Mail, and Einstein from Addison Wesley, and public databases, Swiftcurrent from York University, were accredited to UBC. Existing Conferencing projects such as RAPPI and Project Open Door were made available as was a Teachers' Exchange Bulletin Board and the WaterQuest! Electronic Fieldtrip. Each school could try at least three of these applications. All that each school required to participate was enthusiasm, a computer, modem, phone line and communications and wordprocessing software.

The project was managed from a small project office utilizing modern organizational thinking based on Conversation Theory. This office was available on-line and by telephone. The Project Officer engaged in approximately 20 interactions a day for a two month period providing a consistent, responsive feedback support system for all participants.

The Schools Network Pilot Project was designed to provide an encouraging and enabling infrastructure for teachers to develop the skills and insights necessary for them to assess the various applications. The participants' own reported experiences stimulated a continued interest, awareness and excitement about learning through such an innovative pilot project. An on-line formative assessment was accomplished by establishing and maintaining a record , or conversational audit, of over 600 messages received or monitored by the Project Office in the six week period of project activity.

This method allowed the valuation of a learning experience by encouraging descriptive, generative feedback from participants while they were actively engaged in the project. It is possible, through analysis of this audit to trace the development from the first tentative efforts to use the system to the sophisticated responses received only weeks later, which demonstrated a sophisticated degree of technical facility with the system.

A Summative Assessment was also conducted using an on-line questionnaire designed to encourage participants to describe and assess their experiences during the Pilot Project. It was composed of twelve open-ended questions which covered diverse aspects of the Pilot Project.

It was clear from this extensive assessment of the project that teachers appreciated the opportunity to learn by doing and that they were extremely interested in applications such as the WaterQuest! electronic fieldtrip which clearly demonstrated a useful new approach to the curriculum made possible by computer and communications technology.

OTHER COMMUNICATION BASED PROJECTS

We have been involved in the development of a number of "networking" approaches involving children and computers including RAPPI and Project Open Door.(Ref. 3) We were involved in the design of the first electronic fieldtrip which linked students in Europe, Britain and North America.(Ref. 4) We also managed an AT&T sponsored electronic fieldtrip between schools in Canada and the US. (Ref. 5) Currently we are demonstrating an electronic fieldtrip on urban archaeology between Amsterdam and Western Canada.

A NEW METHODOLOGY

The concept of communication based education is an attempt to approach the curriculum in a real-world manner by allowing students and teachers to experience their learning through hands-on activities. It is based on Conversation Theory (Ref. 6), a modern cybernetic and systems approach to understanding learning. Conversation Theory defines learning as resulting from *conversations* , that is, interactions among participants or perspectives which lead through a process of mutual agreement and disagreement to concept sharing and understanding. Such conversations can be within the mind itself, with other persons and among social groups. Conversation Theory complements both Information and Communication Theory in that it defines conversation as communication *with meaning* .

Communication based education focuses on the nature of meaningful communication and how it can be facilitated within the classroom as well as among individuals and groups and among classrooms around the world through the use of telematics. In particular, this approach strives to identify the nature and quality of this new "informational space" that students must learn to live within. Adult students in open learning systems have successfully demonstrated the potential of these new learning methods.

For example, the concept of WaterQuest! electronic fieldtrip links students in three geographically separate schools to study each others water supply. This involves research about where each other lives as well as meeting the other two classes by audio conferencing and computer conferencing to compare research notes with the actual reported experience of those who live at the other sites. These interactions involve conversations among students in the class, between the classes, and with people in their community. Students also conduct water tests in their own community and exchange data among the three sites to build a composite picture of similarities and differences in water treatment in the three sites. This specific application of communication based education highlights the powerful experiential learning that computer communication links make possible. Students are involved in science, math, geography, communications and social studies while they apply skills in experimentation, research, computation, writing and listening using electronic mail, word processing, and data bases.

Through our work we have designed and field-tested the methodology described in this paper and have developed a framework for educational change through managed innovation. In particular, we anticipate the development of an international Learning Network for Schools that would incorporate a number of features such as access to useful interactive databases, a lesson-plan exchange cooperative, electronic journals, electronic bookstores offering access to learning materials, electronic fieldtrips among countries, administrative services for school districts, and professional development teleseminars for teachers. Such a network would be open to both public and private agencies and would provide a major forum for educational change capable of respecting regional and national distinctions yet providing a coherent learning system for all who use it.

REFERENCES

1. Fred D'ignazio-"Distance is a State of Mind" COMPUTE!'s Gazette, Sept.,86
2. Kathleen Forsythe-"A Web of Diamonds: The Learning System as a New Paradigm for the Information Age", International Council on Education for Teachers,Vancouver, 1985
3. Kathleen Forsythe, Roger Hart, Gerri Sinclair-"Snowflakes and Diamonds: New Communication Domains for Children", Children in the Information Age, Sophia, 1986
4. Richard Civille-Evaluation of the PEN-Quest Pilot Project, Washington Research Institute, 1986
5. Richard Civille-WaterQuest! Electronic Field Trip: Demonstration Project Report, Snowflake Communications Ltd., 1987
6. Gordon Pask-Conversation, Cognition and Learning (Elsevier, Amsterdam, 1975a)
-Conversation Theory: Applications in Education and Epistemology (Elsevier, Amsterdam, 1976b)

THE MIXED MODE VIDEODISC

BY JOHN M. HARTIGAN

THE ATTRIBUTES OF INTERACTIVE VIDEODISC ARE WELL KNOWN WITHIN A LIMITED POPULATION.

THE CAPABILITY OF A CONSTANT ANGULAR VELOCITY VIDEODISC SYSTEM (CAV) TO STORE AND RETRIEVE 54,000 ANALOG VIDEO FRAMES OR PICTURES PROVIDES THE VISUAL ENHANCEMENT FOR A WIDE RANGE OF TRAINING, TEACHING AND INFORMATION PROCESSING APPLICATIONS.

THE RANDOM ACCESS NATURE OF THE DEVICE MAKES IT A NATURAL ADJUNCT TO, OR PERIPHERAL FOR, A VARIETY OF COMPUTER BASED INFORMATION PROCESSING SYSTEMS.

CONCATENATION OF THE PICTURES RESULTS IN THE PERCEPTION OF MOTION AND IN SOME CASES ANIMATED, OR CONSPICUOUSLY ARTIFICIAL MOTION. THERE ARE SOME SYSTEMS IN WHICH THE SYSTEM ACCESS SPEED IS SO GREAT THAT FRAMES WHICH ARE NOT ADJACENT ON THE DISC CAN IN FACT BE CONCATENATED WITH THE RESULT BEING PERCEIVED MOTION AND/OR ANIMATION.

THE SINGLE MOST VALUABLE ASSET OF THE CAV DISC DERIVES FROM THE FACT THAT ONE COMPLETE REVOLUTION OF THE DISC RELATES PRECISELY TO ONE VIDEO FRAME (A CAV DISC ALWAYS ROTATES AT 1,800 RPM). THUS, WE ARE ABLE TO IDENTIFY EACH FRAME NUMERICALLY AND THE SYSTEM IS CAPABLE OF LOCATING ANY INDIVIDUAL FRAME OR STRING OF FRAMES.

THE CONCATENATION OF FRAMES MAY BENEFIT THE END USER IN SEVERAL WAYS. SINCE IT IS NOT POSSIBLE TO PROVIDE ANY USEFUL SOUND WITH THE CONTINUOUS PLAYING OF A SINGLE FRAME ON A VIDEODISC, THE PRODUCER MAY RESORT TO USING MOTION SEQUENCES TO PROVIDE AN AUDIO MESSAGE. THE USE OF MOTION MAY ALSO HELP TO EXPLAIN OR DESCRIBE A COMPLEX PROCESS.

EACH TIME THE PRODUCER RESORTS TO THE USE OF MOTION HOWEVER, THE MOST VALUABLE ATTRIBUTE OF THE CAV DISC, THE LARGE QUANTITY OF SINGLE FRAMES IS DIMINISHED.

THE PHYSICAL DIMENSIONS OF THE DISC LIMIT THE CAV DISC TO 54,000 SINGLE FRAMES, A MAXIMUM OF 30 MINUTES OF MOTION, OR SOME COMBINATION OF BOTH. IF THE PRODUCER OPTS FOR 15 MINUTES OF REAL MOTION THEN THE NUMBER OF STILL FRAMES IS SUBSEQUENTLY REDUCED TO 27,000.

IF A USER HAS A NEED FOR ONLY MOTION THEN IT IS POSSIBLE TO USE THE CONSTANT LINEAR VELOCITY VIDEODISC (CLV) AND OBTAIN ONE FULL HOUR OF MOTION, WITH STEREO SOUND OR 2 CHANNEL SOUND.

ALTHOUGH ALL THE LASERVISION FORMAT OPTICAL DISC PLAYERS & DRIVES ARE CAPABLE OF INTERPRETING AND PLAYING EITHER CAV OR CLV DISCS THE PROCESS IS GENERALLY AN EITHER OR SITUATION.

BY CONVENTION, WHEN A DISC IS IDENTIFIED AS A CLV FORMAT DISC THE PLAYER AUTOMATICALLY DISABLES CERTAIN SYSTEM ATTRIBUTES COMMON TO CAV OPERATION, FRAME SEARCH, STILL PLAY (REPEAT PLAY), REVERSE PLAY, AND STEP OR SLOW MOTION FUNCTIONS ARE DISABLED WHEN A CLV DISC IS PRESENT.

THIS IS NECESSARY BECAUSE A CLV DISC MAY HAVE (ON THE OUTER RADIUS) AS MANY AS 3.0 FRAMES PER REVOLUTION OF THE DISC. ATTEMPTING TO OPERATE IN SINGLE FRAME MODE IN THIS REGION OF THE DISC WOULD CREATE A VERY DISTURBING VISUAL ANOMALY. IN ADDITION AS THE READING LASER BEAM MOVES OUT ONTO THE OUTER RADIUS THE ROTATIONAL SPEED OF THE DISC IS REDUCED EVENTUALLY TO 600 RPM.

THE ATTRIBUTES OF CAV ARE ONLY USEFUL WHEN THERE IS PRECISELY ONE FRAME PER REVOLUTION (OR ALL THE FRAMES IN ANY ONE ROTATION ARE IDENTICAL) AND THE DISC IS ROTATING AT 1,800 RPM. THE 1,800 RPM IS KEY TO SINGLE FRAME VIDEO WHICH IS RECORDED AT 30 FRAMES PER SECOND OR 1,800 FRAMES PER MINUTE.

AS WITH MOST MEMORIES, FILE SERVERS AND INFORMATION STORAGE DEVICES, THERE SEEMS TO BE A CONSTANT QUEST FOR MORE SPACE IN THE DEVICE (THE POSTULATE SEEMS TO APPLY TO FILE DRAWERS ALSO, POSSIBLY MURPHY CAN GENERATE A THEOREM FOR US).

SO IT IS WITH VIDEODISCS, AND PRACTITIONERS CONSTANTLY DEMAND SOME STILL FRAMES AND MORE MOTION VIDEO REAL ESTATE.

THE ONLY PRACTICAL WAY TO ACHIEVE THIS IN CURRENT SYSTEMS IS TO COMBINE SOME CAV (SINGLE FRAME) AND CLV (EXTENDED PLAY) DATA ON THE SAME 30 CM DISC. IN FACT, THAT IS EASILY ACCOMPLISHED UNDER NORMAL MASTERING PROCEDURES.

IN CLV MODE THE NUMBER OF FRAMES PER REVOLUTION GRADUALLY INCREASES FROM THE INNER TO THE OUTER RADIUS OF THE DISC. NO EFFORT IS MADE TO ALIGN

THE SWITCHING POINTS OF THE INDIVIDUAL FRAMES AND THE RESULT IS FREQUENTLY A NOISY DISC OR A DISC WHOSE QUALITY IS DIMINISHED DUE TO FRAME TO FRAME CROSS TALK. THE PROBLEM HAS BEEN CROSS TALK IN THOSE AREAS OF THE DISC WHERE SWITCHING POINTS, FROM ONE FRAME TO THE NEXT, OCCURRED WITH THE SWITCH POINT ADJACENT TO VIDEO DATA ON THE PRECEDING FRAME.

SINCE CAV OPERATES AT PRECISELY ONE FRAME PER REVOLUTION, ALL OF THE SWITCHING POINTS ARE LINED UP AT THE SAME POINT ON THE DISC RADIUS. AS A MATTER OF FACT ONE CAN VISUALLY OBSERVE THIS BY LOOKING AT A CAV DISC.

A THIRD METHOD OF OPERATION WHICH ALLOWS PUTTING ONE HOUR OF MOTION ON A DISC IS CALLED CONSTANT ANGULAR ACCELERATION (OR CAA).

IN THE CAA DISC THE RULES FOR CLV ARE GENERALLY OBSERVED. BUT, AN EFFORT IS MADE TO ALIGN THE VIDEO SWITCH POINTS TO REDUCE OR ELIMINATE THE CROSS TALK THAT CAN OCCUR IN THE TRUE CLV MODE BY CHANGING ROTATION SPEED IN INCREMENTS INSTEAD OF CONTINUOUSLY VARYING THE ROTATIONAL SPEED AS DONE IN TRUE CLV MODE. IN THIS WAY SWITCHING POINTS ARE ALIGNED IN GROUPS OR BLOCKS.

THE CAA DISC BEGINS THE RECORDING OR MASTERING PROCESS AT 1,800 RPM OR 1 FRAME PER REVOLUTION. AS THE INFORMATION SPIRALS OUTWARD, THE VELOCITY OF THE DISC INCREASES BEYOND AN ACCEPTABLE LEVEL AND THE DISC ROTATION SPEED MUST BE DECELERATED TO ACHIEVE THE CORRECT WRITING SPEED.

THERE ARE IN FACT THREE AREAS ON THE DISC WHERE COMPLETE STILL FRAMES CAN BE LOCATED.

THE OPTIMUM AREA OF COURSE IS FROM THE START POINT 55 MM THRU 58 OR 59 MM OF THE DISC. THIS TRANSLATES TO SLIGHTLY MORE THAN 2,700 FRAMES (APPROXIMATELY 1.5 MINUTES OF VIDEO).

IT IS A NORMAL PART OF THE LASERVISION PROCESS FOR THE DISC TO ROTATE AT 1,800 RPM (OR PRECISELY 1 FRAME PER REVOLUTION) DURING THE FIRST 4.5 TO 5 MM OF THE DISC REGARDLESS OF CAV OR CLV MODE. THE SPEED OF THE DISC MASTER IS SET BY THE OPERATOR. SPEED CHANGES ARE PROGRAMMED INTO THE MASTERING BENCH.

APPROXIMATELY 1/3 OF THE DISTANCE INTO THE DISC IS AN AREA WHEREIN THERE ARE PRECISELY 2 FRAMES PER REVOLUTION. ALTHOUGH THESE FRAMES COULD BE STILL FRAMES (IF THEY WERE DUPLICATES) THE PRECISE LOCATION MUST BE DETERMINED EXPERIMENTALLY AND WE DO NOT RECOMMEND SUCH USE AT THIS TIME. NEAR THE OUTER RADIUS IS ANOTHER AREA IN WHICH THERE ARE PRECISELY THREE FRAMES PER REVOLUTION. THIS TOO IS NOT CONVENIENTLY ACCESSIBLE. IF IT WERE, SUCH USE WOULD OVERCOME SOME OF THE SLOWER SEARCH TIMES THAT RESULT FROM SWITCHING TO MOTION OPERATION FROM STILL OPERATION.

IF THE DISC PLAYER CAN BE COMMANDED TO COUNTERMAND THE NORMAL RESPONSE TO A CLV (OR CAA) DISC AND NOT LOCK OUT THE CAV ATTRIBUTES, EVEN THOUGH THE PLAYER IS OPERATING WITH A CLV DISC, THEN WE CAN SEARCH TO AND LOCATE A SINGLE FRAME LOCATED WITHIN THE FIRST 4.5 TO 5 MM OF DISC OPERATION. SINCE THE VIDEO LAID DOWN HERE IS RECORDED AT 1,800 RPM THESE ARE ALL LOCATABLE SINGE FRAMES.

OTHER THAN THE ROTATIONAL SPEED DIFFERENCES AND THE VARYING LOCATION OF THE START POINTS OF GROUPS OF FRAMES ON THE DISC THE NEXT OBSERVABLE DIFFERENCE BETWEEN CAV & CLV DISC IS THAT CLV DISCS CAN HAVE HOURS: MINUTES: SECONDS ENCODED ON THEM. THE TIME CODE IS ANALOGOUS TO THE SMPTE TIME CODE WHICH IS USUALLY ON THE ORIGINAL MASTER VIDEO TAPE. IN CLV (CAA) MODE THE DISC PLAYER CAN RANDOMLY SEARCH TO ANY ONE SECOND INCREMENT. USING THE PIONEER (6000A SERIES) PLAYERS, A SEARCH TO ANY GIVEN SECOND RESULTS IN THE LASER READER LOCATING THE FIRST TRACK IN THAT SECTION OF VIDEO ON THE DISC.

WITH THE INHERENT ABILITY FOR "INSTANT" TRACK JUMP (PIONEER 6000A SERIES) WITHIN PLUS OR MINUS 100 TRACKS, THE SYSTEM CAN LOCATE THE FIRST FRAME OF ANY SEQUENCE AND EITHER PLAY THAT SINGLE FRAME CONTINUOUSLY, OR STEP INSTANTLY (FORWARD OR BACKWARD) PLUS OR MINUS 15 FRAMES AND PLAY ANY DESIRED FRAME (IN THE 55 TO 58MM BAND) CONTINUOUSLY.
THE STEP ACTIVITY (± 100 TRACKS) IS EXECUTED IN MILISECONDS SO THAT STILL FRAME TO STILL FRAME OPERATION CAN BE EXECUTED WITH VERY LITTLE VISUAL ANOMALY ON THE SCREEN.

ALL THE SEARCHING AND STEPPING CAN BE EXECUTED BY PREPROGRAMMED OPERATION, MANUAL CONTROL OR EXTERNAL COMPUTER CONTROL, GIVING THE VISUAL EFFECT OF A FRAME SEARCH (AS ON CAV). THE DISC CAN CARRY THE INSTRUCTION SET AS WE OBSERVE IN NORMAL LEVEL II OPERATION.

THUS, BY ADHERING STRICTLY TO SOUND, PUBLISHED, LASERVISION PROCEDURES ONE CAN COMBINE A LIMITED NUMBER OF STILL FRAMES FOR INTERACTIVE VIDEO PROGRAMMING AND ALSO BENEFIT FROM THE EXTENDED VIDEO PLAY OF CLV/CAA.

THE RESULT IS AN INTERACTIVE VIDEODISC WITH EXTENDED PLAY CAPABILITIES. THE USEFULNESS OF SUCH A DISC IS THE ABILITY TO DEAL WITH LARGER AMOUNTS OF VISUAL DATA. MORE THAN ONE PRODUCT LINE COULD BE HANDLED AND LONGER VISUAL STORY ITEMS CAN BE ACCOMMODATED. THE CREATION OF THE MULTI PURPOSE INTERACTIVE VIDEODISC IS ACHIEVED.

A FURTHER BENEFIT IS THAT THE EXTENDED PLAYING TIME EFFECTIVELY REDUCES THE DUPLICATING COSTS BY PROVIDING INCREASED PLAYING TIME OF SUCH DISCS.

AS IN ALL VIDEODISC PROJECTS, UPFRONT PLANNING OF THE VIDEO REAL ESTATE IS PARAMOUNT FOR AN EFFECTIVE PROGRAM. CARELESS PLACEMENT OF STILL FRAMES RELATIVE TO MOTION SEQUENCES CAN RESULT IN LONGER THAN NORMAL SEARCHES.

THERE IS NO SUBSTITUTE FOR WELL PLANNED CAREFULLY EXECUTED VIDEO REAL ESTATE MANAGEMENT.

AUTOMATING REGULATIONS WITH STRATHTUTOR, A COMPARATIVE EVALUATION

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ABSTRACT

An experiment is reported in which subjects used a CAL tutorial (built using StrathTutor - a learning-by-browsing, attribute-based tutorial system) to solve problems about housing benefit regulations. The times and accuracies of subjects' performances were recorded and compared with the results of a previous experiment which compared the use of an expert system with use of the actual printed regulations. The average accuracy score was two-thirds correct with no significant accuracy differences found between any of the methods. Unsolicited subjects' comments pointed to the unfamiliar language of the regulations being a source of difficulty and it is concluded that future research must address the issue of knowledge representation using more familiar language and/or graphics. The subjects' observed use of a form of key-word search facility could be said to have ensured that, even in the unlikely domain of regulation automation, they performed with comparable success. It is suggested even the most intelligent of tutoring systems ought to have some form of information retrieval mechanism available under user control.

INTRODUCTION

A previous experiment (ref 1) in the domain of housing benefit regulations found that users' performance was not enhanced (according to comparisons of mean times and accuracy scores between two groups of ten subjects) by using an expert system in a limited problem solving situation. Therefore it seemed opportune to carry out a comparative evaluation of a CAL system in a follow-up experiment, reported here, by building a CAL tutorial for the same domain. The tutorial was built using StrathTutor (ref 2), a learning-by-browsing, attribute-based tutorial system for the Macintosh computer. Further motivation comes from both a) Johnston's remark (ref 3) that, despite the wealth of CAL literature, 'remarkably little concerns the issue of program evaluation' and b) the fact that the previous experiment was carried out within a research paradigm promoted by Brooks (in ref 1) which encourages venturesome experiments (unplanned and planned) in naturalistic (i.e. complex) domains, with a view to determining places in the state-space of human-computer interaction at which greater effort is justified and where the greatest benefits to users may be realised.

STRATHTUTOR

The cost of explicitly controlling very large amounts of frame-based knowledge in CAL/ICAL systems is likely to be prohibitive. For this reason StrathTutor was built to provide a learning-by-browsing, attribute-based tutorial system in which frames are implicitly linked together i.e. the sequencing of frames is deduced by the program. StrathTutor is implemented in BASIC and runs on the Macintosh computer making full use of the WIMP interface. Individual frames have one or more Hotspots (a rectangular area of the screen encompassing a piece of text and/or a graphic) which in turn have one or more attributes assigned to them. Attributes have two possible values - assigned and unassigned. For example, the tutorial developer would assign the attribute 'student' to Hotspots (and hence their parent frames) which made explicit or implicit reference to students. Hotspots may also have Information Boxes associated

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with them. When viewed these Boxes present additional explanatory text. The essence of the four ways of progressing through a StrathTutor tutorial are described briefly below.
1) Choosing Next Frame from the Frame Menu. StrathTutor deduces the Next Frame for display by using attributes in a process of pattern matching on unseen frames.
2) Choosing Select by Title from the Frame Menu.
3) Choosing Select Tour Attributes and Go On Tour from the Guided Tour Menu. This way represents a form of key-word search facility. (The experiment reported here helped provide the impetus for implementing this facility.)
4) Mouse-click on Hotspot. As the mouse pointer moves over a Hotspot, it changes to a bent arrow symbol. If the mouse is clicked at this point, a frame is returned by a process similar to the one described for 1) above.
Note that the above four ways are slightly different to those described in ref 2 and that the CAL system described by Hammond and Allison (ref 4) and StrathTutor are in many ways similar - the differences lie in StrathTutor's implicit linking of frames and the other's more explicit use of the travel metaphor for navigating complex systems.

THE TUTORIAL

The Housing Benefits Guidance Manual (ref 5) extends to twenty-seven chapters plus appendices and is over 500 pages long. In keeping with the previous experiment only Chapter 2 - 'Eligibility for Housing Benefit' - was encoded as a CAL tutorial. Six of the subsections of Chapter 2 were of such a size that they could not be encoded as a single frame. In all, the tutorial comprised fifty-seven frames, fifty-one attributes and sixteen Information Boxes . Note that no attempt was made to simplify the language used in the regulations or incorporate graphical explanations (to maintain consistency with the previous experiment). Information Boxes were used at appropriate Hotspots to encode those relevant parts of the Manual's glossary.

EXPERIMENT

In keeping with the previous experiment, ten subjects were asked to solve four problems involving housing benefit regulations. The task in each problem was to determine appropriate advice or information regarding eligibility for a fictitious claimant of housing benefit. Subjects wrote their answers on answer sheets provided. Again, in keeping with the previous experiment, all the subjects were students engaged in an MSc Information Technology course i.e. they formed a potentially homogeneous group. Subjects were experimented upon one at a time and the experiment took place in a computer laboratory regardless of the fact that other laboratory users were present (in keeping with a naturalistic approach). The procedure adopted for each subject was as follows.
1) Brief subject details were solicited.
2) A brief introduction was given to the Macintosh computer - both hardware and software. This involved giving the subjects a 1-page handout on the four ways of moving through a tutorial and the demonstration of these ways using a tutorial on glaciation. Subjects with little or no experience of the Macintosh computer were given just enough time to become familiar with the WIMP interface.
3) Each subject was told the nature of the problems involved but were not informed of the measurements which were being taken nor advised to complete the tasks as quickly or accurately as possible (in order that subjects would respond in a naturalistic way).
4) Subjects were given the four problems on a piece of paper which also served as an answer sheet.
5) On completion, subjects' solicited and unsolicited comments were noted.
Subjects were timed and a tracing facility was also used to gather data about the subjects' paths taken through the tutorial.

RESULTS

Time and Accuracy Data

Each subject was awarded an accuracy score of between 0 and 4 on the basis of the answer sheet alone. A score of 1 was given for a completely correct answer or 0.5 for an answer which was partially correct. Table 1 shows the time (in minutes) and accuracy data obtained and Table 2 gives the mean time and accuracy measurements (and their standard errors) for not only the StrathTutor experiment but also the previous experiment which compared use of an expert system against use of the actual printed regulations themselves.

Table 1 Time and Accuracy Scores

subject	time	accuracy
J	55	2.5
A	52	4.0
F	45	4.0
H	45	3.5
B	41	2.5
C	39	1.0
G	36	3.5
E	35	2.0
D	31	2.0
I	28	3.0

Table 2 Comparison of Means (Errors)

	time	accuracy
StrathTutor	40.7 (2.8)	2.8 (0.3)
printed	30.9 (2.6)	2.4 (0.3)
expert system	33.8 (2.8)	2.5 (0.2)

The raw data passed skewness and kurtosis normality tests - for which accurate look-up tables are given in ref 6. There were no significant differences in mean accuracy scores. However, an independent t-test applied to the time data for StrathTutor and the printed regulations found a significant difference between means at the 2% level. Note that the results of the t-test are robust against the violation of the equal variance assumption (ref 7). By inspection, there is no significant correlation between the time and accuracy data of Table 1. It is noted that maximum accuracy scores were achieved only twice and only by subjects using the StrathTutor tutorial.

Solicited Comments

Nine subjects said they found the system easy to use, the remaining subject found the system 'reasonable' to use. However, of the nine subjects, three (B,D and J) did mention some initial difficulties. Seven subjects found the system response time to be good, the remaining three subjects found it to be 'reasonable'. All ten subjects had made use of all four ways of moving through the tutorial and all but one subject (Subject F) said that they had used the Guided Tour facility the most. This was confirmed by a partial examination of the trace files. Whilst almost all of the subjects had little or no experience of the Macintosh computer, two subjects (H and I) said they had extensive experience. Again whilst almost all of the subjects said that they had no knowledge of housing benefit regulations, Subjects F and G said that they had claimed or were in the process of claiming housing benefit for themselves.

Unsolicited Comments

Six of the ten subjects (B,E,F,H,I and J) spoke of their difficulty in understanding the language of the regulations. Some of these six subjects were also overheard discussing this very difficulty some weeks after the experiment had taken place.

DISCUSSION AND CONCLUSIONS

Kamman (ref 8) has reported on open-book comprehension for printed instructions and his work substantiates the two-thirds rule of thumb - namely that printed instructions will be understood by their intended readers only two-thirds of the time. The average accuracy score for not only the StrathTutor experiment but also the previous experiment is in keeping with this two-thirds rule. The lack of experience of using a WIMP interface was probably the reason that StrathTutor subjects took longer on average to do the four problems - an interpretation reinforced by the comments of subjects B, D and J. However, the eventual ease with which subjects made use of the WIMP interface and the unsolicited comments made by subjects of their difficulty in understanding the unfamiliar language of the regulations, leads to the conclusion that the problem of understanding printed instructions has been successfully automated using both an expert system shell and a CAL tutorial system. Future research must address the issue of knowledge representation using more familiar language and/or graphics. It should be possible to find better ways of expressing the regulations and improving their comprehensibility. (There is a significant traditional literature on improving the comprehensibility of text - e.g. ref 9.) With potential improvements of 20-30% likely (see ref 8) by simply spending more time 'engineering the knowledge', it is the case that the greatest benefits to users (in the domain of printed regulations) will not be realised through any fanciful improvements to the human-computer interface.

Walker (ref 10) has criticised comparative evaluation as a CAL evaluation technique due to the difficulty of applying the scientific paradigm in such a complex domain. However, the experiment reported here was carried out within a different paradigm which seeks to point the way to where the greatest benefits to users may be realised, and this was done here.

The implementation of a form of key-word search facility in StrathTutor was vindicated by the extent to which subjects made use of this facility. It could be said to have ensured that, even in the unlikely domain of regulation automation, StrathTutor allowed subjects to perform with comparable success to other approaches. It is suggested that even the most intelligent of tutoring systems ought to have some form of information retrieval mechanism available under user control.

REFERENCES

1. A Brooks, A Walker and C Boardman. 'At the Interface of Shell Built Expert Systems' Third International Expert Systems Conference. London 2-4 June. Learned Information Ltd., Oxford. 223-232 (1987)
2. J T Mayes, M R Kibby and H Watson. 'StrathTutor : the Development and Evaluation of a Learning-by-Browsing System on the Macintosh' In Selected Proceedings of CAL'87 appearing as Computers and Education, Volume 12 (1987)
3. V M Johnston. 'The evaluation of microcomputer programs : an area of debate'. Journal of Computer Assisted Learning. 3, 40-50 (1987)
4. N Hammond and L Allinson. 'Development and Evaluation of a CAL system for Non-Formal Domains : The Hitch-hiker's Guide to Cognition' In Selected Proceedings of CAL'87 appearing as Computers and Education, Volume 12 (1987)
5. Housing Benefits Guidance Manual. HMSO. (1985)
6. A Brooks. Internal Report, University Observatory, Department of Astronomy, University of Glasgow. (1983)
7. H O Posten, H C Yeh and D B Owen. 'Robustness of the two-sample t-test under violations of the homogeneous of variance assumption' Commun. Stats.-Theor. Meth., 11, 109-126 (1982)
8. R Kamman. 'The Comprehensibility of Printed Instructions and the Flowchart Alternative' Human Factors, 17(2), 183-191 (1975)
9. J Hartley 'Eighty Ways of Improving Instructional Text' IEEE Transactions on Professional Communication. Vol. PC-24(1), 17-27 (1981)
10. D Walker. 'The evaluation of computer-assisted learning' In World Yearbook of Education 1982/1983 Computers and Education. Edited by J Megarry et al., Kogan Page Ltd., London. 42-49 (1983)

THE HOST IN THE MACHINE: DECORUM IN COMPUTERS WHO SPEAK

Stephen Marcus*

ABSTRACT

This paper discusses whether text on computer screens should be given a human "voice." It focuses on computer-assisted writing instruction and suggests a framework for designing computer personalities to match user preferences.

It is not uncommon for people to imbue the computer with consciousness. This is often the case when they are using interactive software. In some cases the text on the screen, "videotext," asks questions and seems aware of the person's responses. In more subtle cases, people doing word processing report that the screen seems to provide them a sense of audience that they normally don't experience when writing.

In those situations in whichthe videotext has been put there by design, the issues are these: Should videotext be given a "human" voice and -- whether or not it is -- what kind of "host" should it be. Implicitly or explicitly, videotext "speaks." It addresses the user and generates a kind of dialogue. The manner in which that dialogue promotes or interferes with the person's cognitive style and affective disposition influences the human/machine interaction. For example, in one study of some 3000 students receiving most of their course instruction from a computer, they were asked whether they missed the human interaction they would normally have had in the course. Almost half said they didn't, noting that, in fact, they had developed a "friendship" with the machine.

There are legitimate educational, not to mention societal, concerns here, with regard to those who felt friendly toward their computers and to those who didn't. How should videotext address the student in order to establish the most favorable and productive relationship between the person and the machine? What factors should influence videotext design when it _is_ to sound human? And what kind of personality should it be given? Does it _matter_ whether people invest the computer with consciousness? What kinds and ages of students do and don't, and how do their attitudes affect the instructional process?

The situation is complex enough in videotext environments. It is even more problematic where voice-synthesis technology is employed. There is ample evidence of gender bias in courseware and classroom practices involving computers. There is now evidence to suggest that gender stereotypes are being perpetuated in the increasing use of computer-generated speech. Steven Leveen, writing in _The New York Times_, notes that while "millions of mechanical objects are now speaking English -- computers, clocks, elevators, automobiles, vending machines, even bathroom scales,"

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these "talking machines are associating females (i.e., by using female voices) with low-level service jobs, while associating males (by using male voices) with tasks that are broader in rance and higher in status."

Although widespread use of voice synthesizers in courseware is some time away, questions about designing and guiding videotext-human dialogue are immediately relevant -- and may help improve future "talking" software." For example, there is courseware for elementary through university levels that aids students in all stages of the composing process. Characteristically, the software engages the student in "conversations" in a tutorial manner. Such software is rapidly capturing the attention of those who see computers as a major force in not only math and science instruction but in thehumanities. In these latter settings, the sensibilities and reactions of a new population of computer users cannot be assumed to recapitulate those for whom the technology has long been an expected and accepted instructional tool. Yet examination of the dialogues encouraged by such composing-process software may suggest that the congeniality of its host may be biased toward certain learning styles and student personality types.

One framework for assessing aspects of such congeniality is based on the personality theory of Carl Jung as operationalized by the Myers-Briggs Type Indicator (MBTI). The MBTI has been used for over 30 years in educational and vocational counseling and for understanding human relationships. It has also been used for studies in success with computer-assisted instruction and in discussions of programmers personalities. In this session, the framework is applied to existing videotext dialogues and to hypothetical variants.

Even more basic questions exist but are seldom even formulated. Should the computer display the personal pronoun "I" in reference to itself? It very often does, thus encouraging students to think of it as sentient. Conversations with teachers about this issue elicit a variety of opinions, often related to the age of the student in question and on the assumed need of that age group for human contact. Some aspects of teachers' disagreements derive from traditional rhetorical and editorial preferences, yet thedebate often seems more than traditionally intense -- probably because of the medium in question. The power and influence people invest in (or derive from) computers seem to make the issues more volatile. At a grander level, what may be at stake is what Pamela McCorduck refers to (in Machine Who Think) as "the two fundamental attitudes that inform Western views on the subject of (computers). One... says that they are useful, praiseworthy and appealing; the other...says that they are fraudulent, wicked, and even blasphemous." It is the latter view that often seems to underlie the responses of many of those in the humanities and liberal arts.

Part of what is involved here is the need for "confluent computer literacy." Confluent education involves the integration or "flowing together" of the cognitive and affective domains in teaching and learning. The impact of the computer on a person's self-image, sense of power, and affiliations with others is a major aspect of the computer revolution, and these dimensions of the affective domain deserve and require special attention in any attempts to make students more than superficially computer literate.

For those who wish to understand and ameliorate computer-anxiety, while retaining their commitment to enhancing rather than dulling our humanity, there must continue to be critical attention to the design of videotext that is congenial and accessible, that encourages people to use the systems -- especially those people with limited abilities, failing interest, or antipathy toward computers.

As computers reach ever wider audiences, and as more and more teachers are themselves creating educational software, there is the need for guidelines to help attract and hold a user's interest and attention and to elicit the students' best efforts in holding up their end of the conversation.

INTELLIGENT VISUAL INTERACTIVE DOCUMENTS (IVIDs) IN EDUCATION

T.D. McGhee, J.A. Glen*

ABSTRACT

Computer-based techniques for document creation and manipulation exist which can replace or augment many publications which now appear in printed form. The application of these techniques to the field of education can be seen as particularly interesting given the multifarious uses of text and documents in education and the increasing use of computers across the curriculum to disciplines where the traditional numerical capabilities of computers are insufficient and symbolic and graphical manipulation necessary. This manipulation and presentation by computer can offer a number of advantages including the gathering together of teaching material from disparate sources, the on-line provision of explanations and help for the student, and creating 'active' diagrams which may be expanded into greater graphical detail or supplemented by on-screen text as required. The use of such active diagrams is particularly interesting given the increase in group teaching activities involving students of different abilities with such diagrams offering the possibility of having different levels of teaching available on the same computing package. This paper will discuss the background to the field and look at efforts which have been made to create Intelligent Visual Interactive documents (IVIDs) using techniques which derive from Knowledge Based Systems (KBS). A number of different approaches are discussed including 'text animation' as exemplified in the expert system building shell ESP ADVISOR, hypertext (an interactive graphics based approach in an icon/window based environment) and the role of Object Oriented programming in CBT. Examples of these approaches will also be discussed and include a prototype expert system on Quality Assurance (created using ESP ADVISOR) which is planned to be used as a training module for a variety of interested parties and an 'intelligent' car manual created using Object Oriented programming. The extent to which the various techniques have been successful in aiding or supplanting the written word and future developments in the field are considered.

INTRODUCTION

Computer-based techniques exist to replace and augment many publications which now appear on printed form. In the past such techniques have been fairly primitive and the electronic documents available on computer have had few advantages over paper.

Developments in Artificial Intelligence (AI) and hardware/software technology have reached a stage where the manipulation of electronic documents can more fully utilise the advantages of modern computers adding to the student's use and perception of the information rather than merely serving as an electronic mirror of paper text. It is now possible to include a level of intelligence in electronic documents allowing flexible interactivity along with visual graphical representations of the concepts contained in the text. Such intelligent visual interactive documents can be termed by the acronym IVIDs.

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IVIDs can be seen as an attempt at human-oriented rather than machine-oriented design where the needs of the student are uppermost rather than the constraints or possibilities imposed by the technology.

CONCEPTS

The differences between the paper and the electronic medium raise some interesting points about how best we can manipulate documents in their computerised form in order to arrive at documents which are intelligent visual and interactive.

PAPER DOCUMENTS

Reading from a book usually involves actual physical contact between the reader and the book. Books are solid objects and our sense of touch is important in manoeuvring the book to the optimum position for reading. People tend to pore over a document, sometimes cupping their hands around their eyes, symbolically shutting out external interruptions.

Books usually are portable, can be tucked into briefcases and carried around. The student can skim or scan through a book, picking out salient points without necessarily carefully reading all the material. Books can be marked at interesting points for the reader and easily turned back to the beginning again.

Paper books and documents can also be very bulky, especially on a technical subject. Paper can get lost and is difficult to update quickly. Often information required for a specific task is spread over disparate locations and is difficult to collate quickly. Paper documents are usually linear, going from start to finish in a straight progression. This does not mirror the way people actually think, in concepts linked by subject matter, and so the the linearity of paper text can be seen as an artificial imposition (Ref 1).

COMPUTER DOCUMENTS

Traditionally computers are good at being numerical calculating machines and have had more difficulty with symbolic or textual manipulation. Word processing apart, the manipulation of text in computers so far has been primitive. Few of the advantages of paper, its tactility, portability, manoeuverability and the ability to pore over and concentrate on the subject matter have been retained in its electronic form. We are left with line after line of straight text with the added disadvantages of screen flicker and computer heat. In seeking to create IVIDs the advantages afforded by computers are utilised,

- interactive graphics can be employed to represent or highlight hitherto purely text-based information. Graphics can emphasise points in the text, increase the reader's interest in the material, replace or clarify technical points and increase the skim and scan ability, much like bold text headings.

- recent cognitive research into left-brain, right-brain functioning has identified one hemisphere as being more adept with smaller chunks of information like text, whilst the other half is better with larger pieces of information like graphics. Thus using graphics can offer the possibility of "expanding the reader's world" (Ref 2).

- computers now offer, through hypertext, the possibility of non-linear documentaton. Hypertext systems allow information to be organised by associated concepts, the way we think, rather than indexed alphabetically or numerically.

- increases in memory capacity via a variety of devices have vastly increased the amount of information which can be utilised, even by personal computers.

- AI techniques are also being utilised to give more flexibility and intelligence to our handling of text and graphics on the computer.

  Thus employing interactive graphics, hypertext systems, concept organisers and AI techniques, our manipulation of text in computers can be greatly enhanced and the following educational advantages accrued:-

  - timeliness, IVIDs can be updated much more rapidly than paper documents or lessons.

  - portability, IVIDs can be on-line at every terminal, there would be no need to carry bulky manuals around.

  - reliability/convenience, an IVID could not be removed from the library or classroom by neglectful students, it would always be available for inspection

  - standardisation, once created the IVID can be easily copied and used as a commonly available document or lesson

  - IVIDs would allow dynamic on-line documentation which could increase the student's attention and involvement

  - centralisation, information could be concentrated for use on-line.

THE FUTURE

Future developments in the field hold more promise for improvements to IVIDs,

- hypermedia, a kind of super-hypertext, will allow all major electronic media to be incorporated into IVIDs, thus text and graphics could be integrated with computer animation, interactive video, sound, etc..

- increases in memory capacity and hardware portability will lead to pocket electronic books combining the advantages of the computer with the physical advantages now enjoyed by the paper book (Ref 3, 4).

IVIDs at YARD

The work done in YARD on IVIDs illustrates different features of the concepts and technology available:

- Expert System on Quality Assurance (ESQA). This employs the text animation expert system shell ESP Advisor. No graphics are supported but ESQA highlights ESP Advisor's method of manipulating complex text to provide an intelligent advice giver and training-module. This is designed for small to medium sized forms concerned with checking their vendor appraisal techniques on Quality Assurance

- the Intelligent Car Manual (ICM), created using Object Oriented programming on the Xerox AI workstation. This is an exercise to illustrate how the concepts of shared objects and classes in the Object Oriented formalism could be used to create an intelligent car manual. The Xerox's WIMP environment supports advanced graphics of the machinery involved.

- the hypertext system Guide has been utilised to create a dynamic, interactive, graphical computer version of an in-house information manual.

- a submission currently before the MSC on implementing AI techniques in the field of Open Learning (in collaboration with Clyde Marine Training Ltd and the Glasgow Nautical College). The basic idea is for an IVID highlighting Collision Regulations for YTS Merchant Navy cadets. This would serve as a training package supplementing college lessons and as a simulation exercise, to be used shipboard.

- a submission before the DTI for an IVID utilising interactive video to highlight techniques involved in Project Management, to be used both in industry and FE, Polytechnic courses in Business Management, Personnel, etc.

CONCLUSION

The research carried out at YARD so far has served to identify and progress concepts and techniques available to create Intelligent Visual Interactive Documents.

The next step will be to implement the techniques described in this paper in the most effective manner for the benefit of the students involved.

FOURTH GENERATION DISTANT LEARNING

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ABSTRACT

Computerisation greatly enhances the efficiency of distant learning schemes which use the postal service as a means of information transfer. We describe here a microcomputer system which uses fourth generation techniques to enable the user rapidly to configure different types of distant learning projects without recourse to further programming. The system permits the creation of a learner file which is configurable thus permitting the collection of appropriate data about the participants. Questionnaires and responses to a particular exercise can readily be generated by creating specific configurable templates and look-up dictionaries for the sophisticated interactive mailmerge facility.

The system can then select out groups from this 'learner' file and generate personalised 'packs' containing questionnaires and labels as required. When completed answer cards to self tests are returned and entered into the system an individualised interactive response is generated again using an appropriately configured template file. Comprehensive enquiry and analysis facilities exist within the system, so that audit of the success of the scheme or specific components can also be performed.

The system presently configured permits three 'projects' to be generated each with a maximum of 32 separate 'exercies' or 'mailings'. Each of the 'projects' is linked to the same population of 'learners' however particular cohorts can be selected out as a 'subset', using any combination of search criteria included in the learner file, and then used for a particular 'project' or 'exercise'.

The use of a computer to help manage a distant learning project greatly reduces the cost of what would otherwise be a labour intensive exercise. Software is however an expensive and valuable commodity. Making use of fourth generation techniques for this type of application increases the potential value of the system and further reduces the cost of computerisation of these projects.

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SCHOOLS/DISTRICT MANAGEMENT COMMUNICATIONS

R. Daniel Norman*

ABSTRACT

School district management communications for many years frequently have been characterized by highly efficient automated data storage and retrieval systems in the district office and a non-automated linkage to schools and field offices that was generally inefficient and slow. The break in this link between the district and individual schools has affected the timeliness and vitality of the decision-making process and the availability of managerial and assessment data for individual school administrators. The Henrico County Public Schools, Virginia, sought to improve this link by the development of a management technology program.

INTRODUCTION

The challenges to effective leadership in individual schools are sometimes synonymous with the ever-present problems related to availability of accurate data for problem-solving, communication dysfunctions which create unneeded and unwanted impediments to identifying clear management goals, and the tendency in school administration to utilize communications in a sometimes secret and oftentimes defensive pattern.

School districts which are large in population as well as districts which cover large geographic areas share the same needs for effective and rapid communications between and among district offices and school sites as does private business. Educational and corporate institutions must depend on rapid and effective communication links for their organizational health. Clearly, the rapid advances in both computer and transmission technologies have opened new and cost-effective opportunities for school districts to improve the necessary communication links among widespread sites. More importantly, the technology provides a new resource in meeting long-identified standards of professional school management and leadership.

DISTRICT OBJECTIVES

The Henrico County Schools, Virginia, is a suburban school district with 32,000 students located at 50 school sites covering approximately 450 square miles. Henrico, like many large school districts around the country, had utilized automated data-storage and retrieval systems for two decades. Personnel and payroll operations, central financial accounting, student attendance systems, school scheduling, and other central support operations were well established. By the early 1980's, communications between schools and the district were still reliant upon paper memoranda and, of course, the telephone. By 1984, Henrico had made a serious commitment to the development of a management technology program which was intended to go beyond the traditional automation and communication of central financial, personnel, or student data. The two specific objectives of this program were (1) to provide an interactive link between the district office and each school, and (2) to utilize that linkage with program applications resulting in (a) more timely and effective communications between managers, (b) improved transmission of data resources, (c) reduction of unnecessary manual work activities at sites which could be replaced by interactive automated report-generating programs, and (d) more informed and aggressive problem-solving behaviors related to instructional leadership.

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SYSTEM DESIGN

The design of the communications system was not unusual in concept although not yet widespread in school districts. Ever since the beginning of automated data processing in Henrico County, the school district, by cooperative arrangement, had utilized the county government's mainframe computer for student scheduling, report card production, and a central county/school district financial accounting system. In this new effort, each school and each central administrative department was linked through the county's central Unisys mainframe. Presently, this system connects fifty schools and all district departments using approximately 125 terminals. All departments and school sites have terminals with off-line personal computer capabilities. Once the system was in place the second objective of effective utilization was pursued.

STUDENT FILE APPLICATIONS

Schools currently access their individual student data files and have the capability of updating most student data directly by terminal. Schools may selectively search the student database on any variable contained in the program. Demographic information on the student database can be down-loaded from the mainframe to disk at local schools and then utilized in developing custom databases or word-processing documents required by school staffs as well as for developing reports.

Expanding program applications in the student and academic files permit an on-line transcript file. Gone will be the repeated hours of manually entering grades and grade points to permit automated calculations. A new transcript file will keep the historic academic records for all students in grades 6-12. This application will permit each school as needed to produce grade point averages (GPA), class rank listings, and summaries of individual student academic histories.

ELECTRONIC MAIL

The system has made possible the implementation of an electronic mail system. The district has abandoned all formal paper memoranda in favor of the electronic transmission of its formal "Special Notice" system. The system permits the district to preset the directory of people or sites which will receive any specific communication. The district may just as easily transmit a memorandum to all principals or direct it only to the management team. In addition to the ability to preset many different distribution lists, electronic mail also permits transmissions between and among schools as well as the district offices. These transmissions are particularly useful to staff when information or requests are being directed to specific sites which are not represented in normal distribution options such as all elementary or all secondary schools.

The electronic mail system will not in itself improve the quality of district communications. It will help solve problems of size and geography by linking sites to a reliable and efficient data source. In addition, the system provides a solution for emergency communication needs. An example is the early closing of school necessitated by inclement weather.

IMPROVINGDATA UTILIZATION

While the benefits of such a management computer network are obvious for improving speed of communicationsand even helping the site manager to process all necessary data and produce all required reports, the real educational opportunity presented by the technology related more closely to increasing the ability of site managers to effectively use institutional data as a planning and leadership resource.

The program combined operational terminals with PC capabilities in order to permit and encourage individual departments or schools to develop many of their own software applications. The network is specifically intended to support school principals and departmental managers in meeting the district's goals of improved data assessment, planning, supervision, and program evaluation.

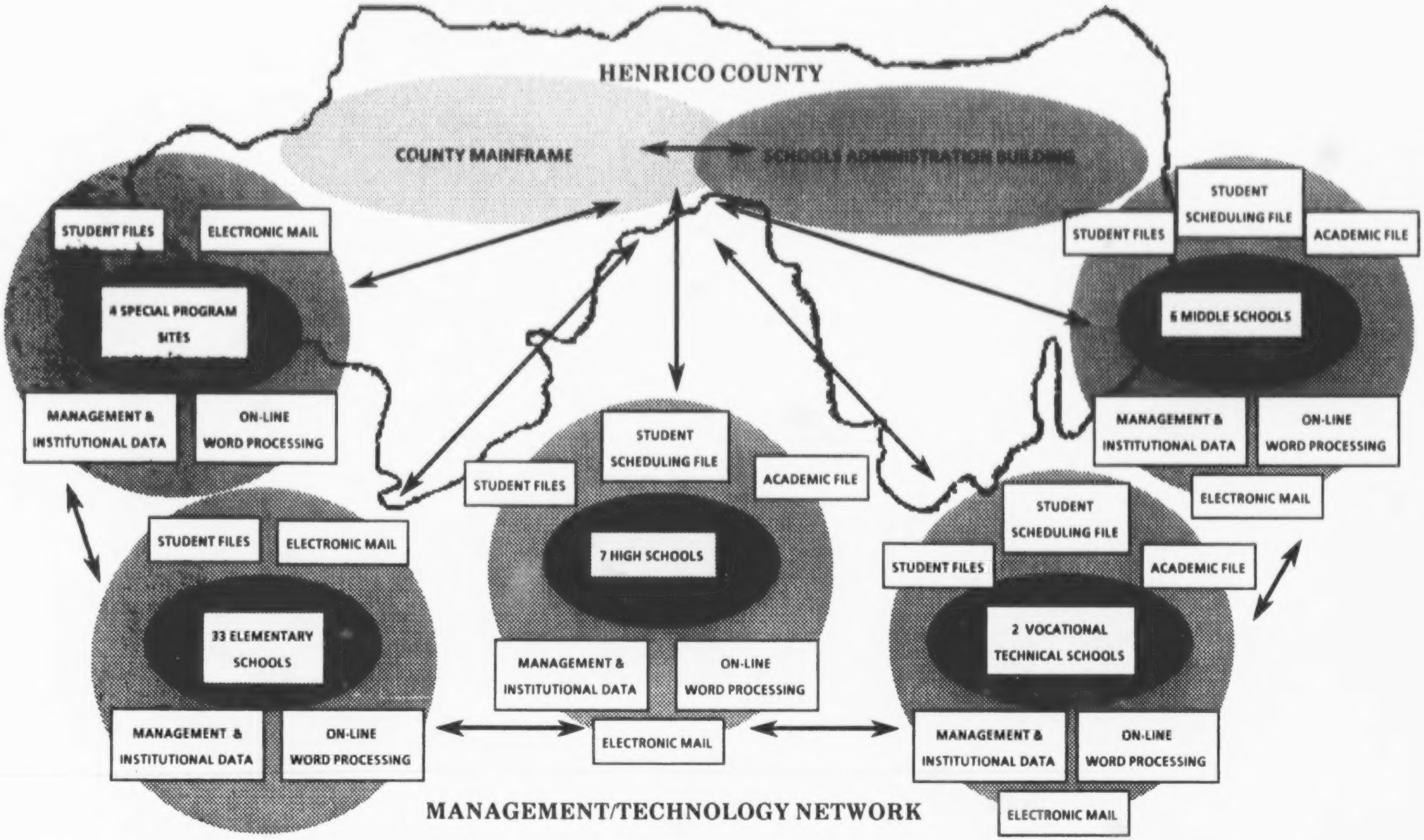
Individual schools will be able to access institutional program and research data in two ways. First, schools may access directly many mainframe files which contain student and academic information. Schools may down-load data from these files at their local sites and, by using a variety of software programs, perform data analysis and simple statistical procedures which may be relevant for program planning or evaluation. This practice has limited use at present because the historic growth of the mainframe database occurred in separate files which did not anticipate such required access. A further integrated database for school institutional data needed in program planning and evaluation must be developed before full utilization of data can be obtained. In the interim a new application of a central word-processing component in the system will provide a method of transmitting planning and evaluation data as a component of the electronic mail network.

All schools presently have one of several word-processing systems available with their terminals. On-line word-processing, to be available in the spring of 1988, will provide either local document storage or central storage in their own partitions of the mainframe storage devices. These files could be transferred intact or in part to other sites for their use or for use with other software. Locally owned or created software could also be stored and transmitted in this way.

The first priority for the district's use of this capability will be to enhance school profile data needed in planning and evaluation. In addition to the traditional district-wide reports on grade analysis, drop-out studies, teacher turn-over, and a host of other data; the district will create custom data reports for individual school sites. These reports will be prepared and transmitted by the on-line word-processing system. The data may not only be received by district reporting variables, it may be utilized and applied at the local school in extended software programs. These databases will provide schools with longitudinal data and statistics so that individual school administrators may use them for identifying changing patterns and trends. These efforts will be supported by staff training in data development. Schools operate too frequently without any measurable sense of the degree to which programs are or are not effective. It is not uncommon for school managers to be uninformed of program characteristics as they relate to student success or institutional effectiveness.

The emphasis in this most important aspect of the management technology program is to improve educational program leadership and decision-making. If school principals are to be effective managers and assume their rightful responsibility for program accountability, they must view effective utilization of institutional program research and statistics as an essential ingredient to planning and accountability. Such networks as described here do not create effective managers, but they can remove a major logistical impediment to strong management.

HENRICO COUNTY PUBLIC SCHOOLS, VIRGINIA


HENRICO COUNTY
COUNTY MAINFRAME
SCHOOLS ADMINISTRATION BUILDING
STUDENT FILES
ELECTRONIC MAIL
4 SPECIAL PROGRAM SITES
MANAGEMENT & INSTITUTIONAL DATA
ON-LINE WORD PROCESSING
STUDENT FILES
STUDENT SCHEDULING FILE
ACADEMIC FILE
6 MIDDLE SCHOOLS
MANAGEMENT & INSTITUTIONAL DATA
ON-LINE WORD PROCESSING
ELECTRONIC MAIL
STUDENT FILES
STUDENT SCHEDULING FILE
ACADEMIC FILE
7 HIGH SCHOOLS
MANAGEMENT & INSTITUTIONAL DATA
ON-LINE WORD PROCESSING
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ELECTRONIC MAIL
33 ELEMENTARY SCHOOLS
MANAGEMENT & INSTITUTIONAL DATA
ON-LINE WORD PROCESSING
STUDENT FILES
STUDENT SCHEDULING FILE
ACADEMIC FILE
2 VOCATIONAL TECHNICAL SCHOOLS
MANAGEMENT & INSTITUTIONAL DATA
ON-LINE WORD PROCESSING
ELECTRONIC MAIL

MANAGEMENT/TECHNOLOGY NETWORK

COMPUTER ASSISTED LEARNING - THE SHIFT FROM TERMINALS TO HOME COMPUTERS

Eileen Scanlon *

ABSTRACT

For fifteen years the British Open University (OU) has been experimenting with the use of computers to provide a variety of learning opportunities.This experience was initially limited to students of the University's maths foundation course learning a programming language. The extent of this provision has been growing ever since, over a range of courses and a range of delivery systems.This paper will report on the 'interim ' experiments which have been carried out on the mailing of hardware and software to our students, and make some predictions about the future of the newly introduced home computing policy and the future development of computer assisted learning (CAL) at the OU.

INTRODUCTION

Since 1970, the British Open University (OU) has used computers to provide learning experiences for its 120, 000 students.This experience was initially limited to exposure to BASIC for students of the University's maths foundation course but was rapidly extended to the provision of tutorial and simulation CAL packages on a range of science, technology and psychology courses.The delivery system used for this tuition was a network of three DEC 2040/60 computers. Students use the computers from terminals in one of the 250 study centres, but these facilities need to be booked in advance and students may live up to 50 miles from their nearest study centre.

EVALUATION OF 1979 PROVISION

In 1979, a series of studies were conducted into the use and effectiveness of this CAL provision (ref 1)These highlighted the low usage of the CAL packages , and showed that students held realistic views about the costs and benefits associated with their use.The benefits which students expected to get out of the tutorial systems included individualised feedback, diagnosis of weak points and revision, clarification and consolidation of difficult concepts. Apart from the actual logistics of study centre usage, we found that they expected problems with bad computer experiences , technical problems and embarrassment at the thought of using a computer terminal with others in the room. Many of the problems of using CAL, such as access, although not specifically related to distance education are certainly not solved within this context. Another range of problems were reported with the simulations used at residential summer schools, where computers were readily available on site, centering on the support providedby documentation and by human tutors.

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MICROS IN SCHOOLS

By 1982, surveys (ref 2) showed that just over one third of our students possessed a microcomputer, either at home or at work, though this access was divided between five popular make/models. Since 1981, we attempted to gain experience in sending out computers and software to students during the production of study packs for the Micros in Schools project,(ref 3). The topics covered by the packs are awareness , educational software, computers in the classroom, microelectronics and inside microcomputers. The packs provide the teacher who studies them with a course of practical work which relates directly to classroom applications of microcomputer technology.The first three packs named above were to be produced in editions for the Apple II, Sinclair spectrum , BBC model B, Research Machines RML 380Z and RML LINK 480Z. The microelectronics and microcomputer packs were to be supported by a special purpose microcomputer. Each pack is designed to support private, personal and classroom practical computing work. The teacher student acquires specific skills and builds up experiences. This is supported by elaborately designed print material, using the three column key/screen/commentary format based on 'so type this', 'you will see this 'and 'the computer responds in this way because'. Then the teacher student widens his experience via print or video based case studies. Finally, he applies his new skills in his own classroom setting.

DEVELOPMENTAL TESTING

This material works successfully with even the most novice students. When the awareness pack was first tested a number of experts expressed concern that the teachers might dislike the extreme hand-holding approach used. In practice more experienced teachers just study the early material more quickly. The key to this success is our insistence that all the material must be developmentally tested by real students in real conditions. Novices encounter a whole variety of conceptual, practical and affective problems with computing work and there is no way of predicting in advance which method will work with a particular set of novices . So we tested versions of the material till we found a version which worked. Finally, the page proofs were checked against the practical computing work by another novice as a single wrong key press remaining at that stage can cause untold problems for an individual learner. The most acute practical problem we faced in the life of the project was maintaining the software components of the packs. We had to deal with one microcomputer which suffers a reduction in available memory when it is upgraded for use with disc drives or networks, and another whose operating system upgrade resulted in problems with a whole variety of programs. Screen resolutions and dialects of BASIC and Logo vary from microcomputer to microcomputer and versions of existing packs for different micro computer took as much as 50 per cent of the original design developement effort. At the same time , computers become more familiar at home and at the place of work our students expectations, behaviour and initial errors change . We needed to test new packs, continually monitor the microcomputer manufacturers initiatives with new software and peripherals and evaluate student use of the packs.

In 1986, this material was extended and integrated into the University's mainstream undergraduate teaching as a course in educational computing. The course is about children learning with computers. Students analyse educational and technical problems in the use of computers in education , gaining a sound understanding of software for schools through working on educational software design and the evaluation of programs. There is a condiderable amount of practical work involved, for which the students must have access to a BBC-B microcomputer with a tape or disk drive and monitor screen. Access to a full version of Logo is also needed, though sets of Open Logo are available on loan for students unable to obtain this. Evaluation studies involving questionnaires to tutors and students of this course, together with some telephone interviewing have been very illuminating. Most striking has been the fact that the practical component has been completely unproblematic. Part of this success is certainly due to insisting on one delivery machine for the course.

HOME COMPUTING

The University has been considering for some time the introduction of a policy which would move the practical computing component of courses into the home. From 1988, students on certain undergraduate OU courses will be expected to have access to their own microcomputer which conforms to the University's home computing policy. The home computing policy states that students on certain specified courses will be expected to rent or buy their own microcomputer meeting a certain specification. The specification is currently met by the Amstrad PC and the Akhter PC, and includes MSDOS, GEM, 512k RAM, single disc drive , keyboard monitor parallel and serial port, mouse and printer. The university is being supported by the Department of Trade and Industry and the Department of Education and Science, which have provided funds for the acquisition of machines for rental by students who do not wish to buy a machine. This will involve 5,000 students on 3 new post foundation courses, two in mathematics, *Fundamentals of computing* and *Computational mathematics* and one an interdisciplinary social science and technology course, *Introduction to information technology: technical and social issues*. In the last mentioned course , an extension of the role of CAL at the OU to computer conferencing is planned, and the formation of informal as well as formal learning networks will be closely monitored.

The most exiting new development in this shift from study centre terminals to home computing is the fact that, from 1989 and beyond , further courses will come under the new policy, providing students with a more varied range of courses using this facility.The new technology foundation course plans to make home computing an integral part of its teaching methods. Home computing offers them significant ways of improving their teaching in critical areas - notably the development of literacy and numeracy skills, and the teaching of modelling, and the course team can not concieve of constructing a course on technology which does not include the dominant technology of our times. Each student will recieve a personal copy of Ashton-Tate 's *Framework* package which enables them to do outlining, word processing, spreadsheet modelling and simple database work. It also enables them to construct a range of graphs from spreadsheet data, and to produce integrated essays containing text, numerical data and graphs.To increase access to the course 2,000 rental machines have been purchased.

An informal evaluation of the machines and software to be used by students was encouraging(ref 4). This test involved the use of ten machines over six months with users with a range of backgrounds in computing, and replicated an earlier finding from the micros in schools project materials,that naive computer users should be given some practical activity to do as early as possible in introductory courses. Audio tapes were also found to be useful in giving naive users initial confidence.

CONCLUSION

Over the last fifteen years, the OU has developed expertise in teaching at a distance with computers. However problems of access have always bedevilled attempts to make the use of computers an integral part of its teaching. A number of interim solutions to the problem of access have allowed us to develop some rules for good course design in this area e.g. developmental testing, learning by doing. We now stand poised to make a full use of the potential of the medium now that problems of access have been overcome.

REFERENCES

1. E. Scanlon, A. Jones, T. O'Shea, P. Murphy, E. Whitelegg, Institutional Research Review,(1) (1982)
2. H. Grundin, Audio Visual Media Research Group Report ,(1982)
3. T. O'Shea, pp123-128 in Informatics and Teacher Training, F. Lovis, E.D.Tagg (eds), 1984.
4. M. Baker, Internal Report

COMPUTER EDUCATION IN THE UNITED STATES OF AMERICA, 1985-87: POLICY ON CURRICULUM, TEACHER TRAINING, CONTROL, AND EQUITY

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ABSTRACT

A three-year study (1985-87) sought to identify, define, and interpret national trends in the United States of America related to state-based priorities for computer education instruction in American public education. State policy initiatives and documented guidelines for educational computing in both elementary and secondary schools, gathered annually from chief state school officers and state legislatures across all 50 states, demonstrated increasing priorities for specific instructional and administrative objectives related to (a) computer science curriculum, (b) teacher training, (c) licensure, (d) involvement of teacher education (post-secondary) institutions, and (e) the role of ethics and equity in computing resource management. Based upon clinical observations of policy initiatives in each state legislature and education agency, a national curriculum model was constructed containing a total of 23 identifiable, instructional goals across a continuum of grade levels from primary to high school.

STATUS OF EDUCATIONAL COMPUTING POLICY IN USA

State policy on curriculum (Stave 1, Table 1)
The status of state-level guidelines for curriculum relevant to computer literacy and computer science instruction indicates that a total of 29 states have developed and/or enacted state-level guidelines for use by local school districts. Due to decentralized authority over the curriculum in many states, most of these guidelines are offerred simply as recommendations or "model programs" for district consideration. ('E' exists; 'I' in progress).

State policy on certification (Stave 2, Table 1)
The status of state-level guidelimes regarding teacher certification for computer literacy and computer science instructional licensure indicates that a total of 18 states possess information regarding current or upcoming state certification considerations for computer literacy and/or computer science teachers. For these states, the main between-state differences centered around whether certification was perceived as mandatory, and whether formal training in computer science was considered necessary. ('M' mandatory; 'D' discretionary; 'E' experience substitutes; 'T' test required; 'P' proposed; 'S' under study).

State policy on teacher training (Stave 3, Table 1)
The status of state-level guidelines related to teacher training provisions for computer literacy and computer science instructional methods indicates that a total of 24 states have designed policy or future preferences concerning the training of teachers in the areas of computer literacy and/or science. For these states, the main differences center around the orientation for inservice versus preservice

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instruction and whether such instruction should be mandatory for computer teachers and users. ('C' part of teacher certification; 'P' preservice; 'I' inservice; 'M' mandatory; 'S' under study; 'R' related fields).

State policy on teacher education involvement (Stave 4, Table 1)
The status of state-level guidelines for involving teacher education institutions (or programs) in the development of computer education curriculum and policy indicates that 15 states have formal documentation regarding cooperative training priorities. The extent of involvement on the part of institutions of higher education is naturally confounded by the existence or nonexistence of certification standards and preservice training requirements. ('U' preservice, undergraduate; 'G' preservice, graduate; 'I' inservice; 'M' mandatory; 'S' under study).

State policy on ethics (Stave 5, Table 1)
The status of state-level guidelines related to policy governing the ethical deployment of educational computing and computer equipment indicates that a total of 16 states have formal policy, guidelines, recommendations, or "structured planning activities" directed at the definition of operating procedures for ethical computing activities. (Note: Wisconsin was the only state to discuss specifically elements of (a) human values and (b) student progress monitoring.) ('C' copyright; 'P' privacy; 'E' courseware evaluation; 'Q' equity; 'S' under study).

STATE POLICY ON COMPUTER EDUCATION CURRICULUM

A total of 32 states supplied interpretable documentation which delineated state requirements or recommendations related to curriculum for computer literacy instruction at the elementary and secondary school level(s). The curriculum documentation supplied by the states was analyzed for (a) specificity of instructional objectives, and (b) grade level of required or recommended offering and mastery. Four generic areas of computer education goals were discernible from the curriculum, and are referred to in this study as: computer operations, computers in society, programming and problems, and computer applications. A total of 23 instructional objectives were synthesized from these materials; and, in addition, the placement of each objective identified across the K-12 grade continuum. This information is displayed in Table 2.

The grade levels noted on the charts may be subject to a number of different interpretations. Some states' responses included the grade levels in which the subject matter was introduced. Other responses listed the level at which mastery was expected. Most states mentioned only the grades in which the materials were covered. "NG" refers to the fact that some states did not specify a grade level, while "IG" means that the state allows the district to determine individually the grade of curricular introduction. If a hyphen appears before a number in the chart, it indicates the level at which the subject matter should be mastered. If the hyphen follows the number, it is showing when the materials were initially introduced.

Of the 300 formal documents supplied by state officials a total of 75 formal citations are worthy of international dissemination, and have been abstracted for each of the policy development areas: curriculum, teacher training, licensure, post-secondary requirements, ethics, and equity.

Table 1. Status of State-Level Interest in the Development of Computer Literacy and Computer Science Policy in the U.S.A., 1987-88.

	Curriculum	Certification	Training	University	Ethics
AL					
AK	E 1-12	S K-12	I K-12	U M	
AZ					
AR	E 3-12		I 3-12	U I M	
CA	I 9-12	M E	S	U G	C E
CO					
CT	E K-12	D S K-12	S R K-12		
DE					
FL	E 3-11				
GA	E 9-12				
HI	E K-12	E K-12	P I R K-12		C
ID	I K-12		I K-12		
IL		T K-12	I K-12		
ID			I K-12	I	
IO		M P 9-12	S 9-12	U G S	S
KS	I K-8	M 9-12	P M R 9-12	U G M	C
KY	E 9-12	M 9-12	P R 9-12		
LA	E 9-12	M 9-12	C P S R K-12	M	
ME	E 9-12			G	C
MD	I 9-12			S	
MA	E	S	S	S	
MI	E K-12	D S			
MN	E K-12	P 10-12	I K-12		C E
MS	E K-12	K-12	M S 9-12	U G M S	
MO		S	C P M K-12		
MT			P M K-12	U M	
NE	I K-12		I S K-12	U S	
NV	E K-12	M	P M K-12		
NH	E 9-12				
NJ		S	P I M		C
NM	I	P K-12			
NY	E 7-8		I K-12	S	P S
NC	E K-12	M K-12	P I K-12	U G	C
ND	E K-12	E 9-12	P R 9-12		
OH		M(9-12) K-12	C P K-12	U G	C
OK		M E *	P R 9-12		Q S
OR					
PA					
RI	E K-12				
SC	E 9-12				C
SD	E	M	S	S	C
TN	E 7-8		I 7-8		
TX	E 7-8	T K-12	C P I K-12	U G	
UT	E K-12	M K-12	C P I M K-12		
VT	E K-12	E 9-12			
VA	E K-12	P-S 9-12	S K-12	S	
WA	I K-12		C P K-12	U M	C
WV	E			G I	C
WI	E K-12	M 7-12	C P M K-12	U M	C Q
WY		S	P M 9-12	U M	

Table 2. Grading Sequence of Computer Education Curriculum by State.
'NG' (no grades indicated) 'IG' (dependent upon district)

	AK	AR	CA	CT	FL	GA	HI	ID	KS	KY	LA	ME	MD	MI	MN	MS
Keyboard	1-8	9-10	9-10	1-4	-5	9-12	3	K-5	K-8			8-12		K-12		K-12
Terminology	1-8	9-10	K-12	K-12	-8	–	3-8	K-5	K-8	11-12	9-12	8-12	NG	K-12	K-12	K-12
Operation	1-8	9-10	K-12	1-12	-3	9-12	3-12	K-5	K-8	11-12	9-12	8-12	NG	K-12	K-12	K-12
Peripherals	1-8	9-10	–	–	-5	–	8-12	K-5	K-8	11-12	9-12	8-12	NG	K-12	K-12	K-12
Software	1-8	–	–	–	-8	–	3-12	6-12	K-8	–	9-12	8-12	NG	K-12	K-12	K-12
History	7-8	9-10	K-12	3	–	9-12	–	K-5	–	–	–	–	–	K-12	–	–
Daily Uses	4-8	–	K-12	1-12	5-8	–	8-12	K-5	K-8	10-12	9-12	8-12	NG	K-12	K-12	K-12
Business Use	4-8	9-10	K-12	–	5-8	–	3-12	6-9	K-8	10-12	9-12	8-12	NG	K-12	K-12	K-12
Careers	7-8	9-10	K-12	–	–	9-12	3-12	6-9	K-8	10-12	9-12	8-12	NG	K-12	–	K-12
Ethics	7-8	9-10	K-12	8-12	5-8	9-12	3-12	6-9	K-8	–	9-12	8-12	NG	K-12	K-12	6-12
Future	–	9-10	K-12	1-12	9-11	–	–	–	K-8	–	–	–	NG	K-12	K-12	K-12
Development	1-12	9-10	K-12	K-12	-11	–	8-12	6-9	K-8	9-12	9-12	8-12	NG	7-12	K-12	9-12
Languages	1-12	9-10	K-12	K-12	–	–	8-12	K-12	–	–	–	–	–	4-12	–	9-12
Logic	7-12	9-10	7-12	–	–	–	8-12	6-12	K-8	12	–	–	–	4-12	K-12	9-12
Prob Solving	4-12	9-10	K-12	–	5-8	–	8-12	K-12	K-8	10-12	9-12	–	NG	K-12	K-12	9-12
Word Processing	7-12	9-10	K-12	5-8	–	9-12	6-12	6-9	K-8	–	9-12	8-12	–	K-12	K-12	9-12
Spreadsheet	7-12	9-10	K-12	–	–	9-12	6-12	6-9	–	–	9-12	8-12	–	7-12	K-12	9-12
Data Base	7-12	–	K-12	6,8,12	–	9-12	6-12	6-9	K-8	–	9-12	8-12	–	4-12	K-12	9-12
Telecommunicate	7-12	9-10	K-12	8-	–	–	–	–	K-8	–	9-12	8-12	–	7-12	K-12	9-12
Graphics	7-8	9-10	K-12	–	–	–	–	6-9	K-8	–	9-12	8-12	–	4-12	K-12	9-12
Robotics	7-12	9-10	–	7-12	–	–	–	–	K-8	–	–	–	–	K-12	K-12	9-12
Sound	7-12	9-10	–	–	–	–	–	–	K-8	–	–	–	–	K-12	K-12	9-12
Artif Intellig	–	–	–	8-	–	–	–	–	–	–	–	–	–			9-12

	NV	NH	NM	NY	NC	ND	OH	SC	SD	TN	TX	UT	VT	VA	WV	WI
Keyboard	K-12	9-12	NG	4-6	K-8	5-6	IG	9-12	9-12	7-8		K-6		–	NG	4-12
Terminology	K-8	9-12	NG	4-6	K-5	K-9	IG	9-12	9-12	7-8	7-9	K-6	–	NG	NG	K-12
Operation	K-12	9-12	NG	K-3	K-5	9-12	IG	9-12	9-12	7-8	7-9	K-6	K-8	NG	NG	K-12
Peripherals	3-12	9-12	–	10-12	K-5,9	K-9	IG	–	9-12	7-8	–	K-6	–	–	NG	K-12
Software	K-8	9-12	NG	K-3	K-5	9-12	IG	9-12	9-12	7-8	7-9	K-6	K-8	NG	NG	K-12
History	8-12	9-12	NG	–	K-5	9-12	IG	9-12	9-12	7-8	7-9	7-8	2-8	NG	NG	K-12
Daily Uses	K-8	9-12	NG	–	K-5	9-12	IG	9-12	9-12	7-8	7-9	–	2-8	NG	NG	K-12
Business Use	K-12	9-12	NG	4-6	K-9	9-12	IG	9-12	9-12	7-8	7-9	7-8	2-8	NG	7-12	4-12
Careers	8-12	–	NG	4-12	7-8	–	IG	9-12	9-12	7-8	–	9-12	–	–	NG	K-12
Ethics	3-12	9-12	NG	7-9	8	K-9	IG	9-12	9-12	–	7-9	9-12	9-12	NG	NG	K-12
Future	9-12	–	NG	–	9-10	–	IG	9-12	9-12	7-8	–	7-8	2-8	NG	NG	K-12
Development	3-12	9-12	NG	7-12	K-5	9-12	IG	9-12	9-12	7-8	7-9	K-6	2-8	–	NG	K-12
Languages	K-12	–	–	7-12	K-5	9-12	IG	–	9-12	–	K-9	–	K-12	NG	9-12	K-12
Logic	–	9-12	–	7-12	10-12	9-12	IG	9-12	9-12	7-8	7-9	K-6	–	NG	NG	K-12
Prob Solving	3-12	9-12	NG	7-12	6-9	9-12	IG	–	9-12	7-8	7-9	K-6	–	NG	NG	K-12
Word Processing	3-12	9-12	NG	10-12	8-12	11-12	IG	–	9-12	7-8	7-9	7-8	K-8	NG	NG	K-12
Spreadsheet	8-12	9-12	NG	10-12	8-12	11-12	IG	–	9-12	7-8	7-9	7-8	4-8	NG	NG	5-12
Data Base	8-12	9-12	NG	10-12	8-12	11-12	IG	–	9-12	–	7-9	7-8	5-8	NG	NG	3-12
Telecommunicate	–	9-12	–	10-12	8-12	11-12	IG	–	9-12	–	7-9	7-8	5-8	NG	NG	3-12
Graphics	K-12	–	–	10-12	9-10	9-12	IG	–	9-12	7-8	–	–	7-8	NG	NG	K-12
Robotics	–	–	–	–	9-10	–	IG	–	9-12	–	–	–	–	–	10-12	K-12
Sound	–	–	–	–	9-10	9-12	IG	–	9-12	–	–	–	9-12	NG	NG	–
Artif Intellig	–	–	–	–	9-10	–	IG	–	9-12	7-9	–	7-8	–	–	NG	K-12

COMPUTERS IN THE CLASSROOM: STATE LEADERSHIP INITIATIVES - CALIFORNIA AS A CASE STUDY

Barbara O'Connor

ABSTRACT

In 1982, the California Legislature recognized the need for statewide leadership to address the integration of new information technologies into the K-12 classrooms of the state. Their concern for the potential social stratification based on an information rich/information poor citizenry, the need for technologically literate workers and an increasing non-primary English speaking student population caused them to enact Assembly Bill 803, the Educational Technology Local Assistance Act. The purpose of the law was to set up a state commission of educators, industry representatives and technologists to devise state initiatives to infuse instructional technology into the K-12 curriculum. The first year funding for the program was one million dollars. Within four years, funding for the program grew to $28 million. By the end of 1987, sixty percent of the state's schools will have received a local assistance grant from the program.

This paper will describe the evolution of California's state leadership strategies: coalition building between business and industry and school sites, the technology and curriculum software guides and other software development programs, model technology demonstration sites, distance learning and classroom based telecommunication pilot projects, summer technology training institutes for teachers and the local site matching grant program for equipment purchase.

In 1988, the California Legislature will review the progress of AB 803 and hold re-authorization hearings. This paper will evaluate the success of the statewide leadership strategies and make recommendations for future directions.

INTRODUCTION

When the California Legislature chaptered AB 803, the Educational Technology Local Assistance Act, into law in 1983, its charge was to infuse technology into all of the 7,100 K-12 schools in the state. At that time, most of the schools in California had no computer labs. Apple Corporation, through their "Kids Can't Wait" program, had just given one Apple computer to each school to stimulate interest in using computers in the classrooms. Most of the state's teachers knew nothing about operating a computer, let alone using one as an instructional tool in their classrooms. There was a small cadre of teachers, mostly computer programers and "techies" who were concerned about instituting computer literacy programs and horror stories were abounding about equipment that was given or purchased that was still sitting in a closet, the principal's office, or in the hands of the one computer teacher on the site. Most of the children in California's schools had no exposure to computers during their educational careers.

We knew from our Title IVC federal grant experience, the National Diffusion studies and the Rand Corporation studies that any infusion of

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new programs needed to be locally owned and a part of the ongoing activities of the school site. Consequently, the development of state initiatives to accomplish the charge of AB 803 was a formidable challenge.

THE IMPLEMENTATION OF AB 803

Early in the process of developing policies and programs to implement AB 803, the Educational Technology Committee recognized that in order for technology to be utilized effectively in California's classrooms, three distinct elements would have to be present: 1) hardware, in adequate quantities, with capabilities matched to instructional uses; 2) software, of high quality, which complemented, supported, and strengthened curriculum content and instructional strategies; and, 3) training, for teachers, administrators, and all school personnel, to enable the effective integration of technology throughout the school. We recognized that we needed to approach implementation from three directions: first, by providing resources to schools and districts to acquire hardware and software and to provide training; second, by providing statewide coordination to achieve cost-savings, efficiency and to reach the broadest possible audience; and third, to provide leadership, a vision and a plan for achieving the vision. We needed to promote research, development, and dissemination of technology practices, materials, and strategies which are integral to achieving broader educational goals. Over the past four years the Educational Technology program has expended over $81 million to fund these three key elements for technology infusion. The largest block of funds has been allocated on a competitive basis to promote small-scale program development based on school and district level technology plans This Local Assistance Program has stimulated equipment and software acquisition, extensive planning and staff development and tripled the number of computers in use in California schools. These small scale grants ($8,000 to $24,000 per site) have put more than 115,000 computers in California's schools. They have fostered cooperative use of district funds because they require a 10% district match. We estimate that, due to AB 803 funds, there is a computer available, on the average, at a rate of one for each 39 students. California, with the largest number of computers statewide, nevertheless ranks only 45th among all states in the USA in the ratio of students to computers. Texas, our closest competitor in student population, ranks 24th, with one computer for every 34 students. We have funded 61% of the state's schools to date.

To ensure an expanded use of instructional video in conjunction with the expanded use of computers in the classroom, in 1985 the program gave every school in California a VCR for classroom use. AB 803 funds have been used to expand video services. We have supported seven regional instructional television agencies and have used state license acquisition opportunities to acquire instructional programs. We have expended $9.2 million in the video area in the past four years.

We have spent nearly $5 million over the past four years in the development of software review guidelines, software and video quality review and curriculum correlation efforts, and distribution of samples of high quality software to every school. California has led the nation in terms of providing resources to teachers and schools related to software and technology curriculum materials. The Technology in the

Curriculum materials and the annual Software Preview Guide are known throughout the United States, and are viewed by many technology-using educators as among the most valuable software review resources available.

We have developed a number of publications which provide policy and technical advice to all schools and districts. Computers in Education: Goals and Content; outlines the ways in which computers can and should be used throughout the curriculum. Guidelines for Educational Software in California Schools, developed to fulfill requirements of AB 803, have served as the basis for all software review in California subsequent to 1985. The Computer Applications Planning Guidebook provides a model process for districts and schools as they develop local technology plans.

We have dedicated over one million dollars to partnerships with private business to develop comprehensive technology-based products designed specifically to address curricular priorities in California. Particularly with computer software, the private sector has been generally unwilling, because of high costs, to develop comprehensive instructional materials. Thus, we are using AB 803 funds to subsidize development efforts which will address instructional priorities and serve as models for other developers. With marketing discounts for California schools, the initial costs will be easily recovered. In addition to funds from adoption/expansion grants used at the local level to provide staff training--we estimate that perhaps 8% to 10% or \$3 to \$4 million, have been spent at that level--we have spent \$6 million in the form of grants awarded to public institutions of higher education (IHE) to conduct intensive, four-week summer institutes involving approximately 1,200 teachers from across the state. In addition to developing effective technology-based instructional programs in their own classrooms, these teachers will also begin to serve as trainers of others. Each participating IHE has also incorporated successful practices from the summer institute into its approved preservice program, extending the benefits of the summer institutes to those teachers who will move into their own classrooms in the near future.

Finally, \$2.5 million has been awarded through a competitive process to school districts to develop five technology-infused demonstration complexes. (Each complex has an elementary, intermediate, and secondary school that feed each other. Our goal is to trace a student's use of technology over the life of his/her school career.) Each complex represents a different demography of students, has a different technological plan of delivery, a carefully designed research component, and will serve both as practical technology-based instructional models and as the object of study of the processes undertaken in implementing a comprehensive technology-infused administrative and instructional program in the coming years.

WHERE DO WE GO FROM HERE?

We have accomplished a great deal in the four years of AB 803 but our need for new strategies and approaches continues. We still need to provide initial funding to 40% of our state's schools and if technology is to really be pervasive in education and allow us to realize cost savings, enhance student learning and expand the professional stature of the teacher, then the use of technology in all of our schools must become an integral part of the educational process. We need to fund expansion of technology in all schools after our initial funding phase is complete. Technology has a much larger role to play in enhancing the curriculum and improving the productivity of our schools. We need to explore the broadest definitions of telecommunications and open network architecture solutions to provide cross machine compatibility, technology based distance learning services, data base access in the classroom, electronic messaging, staff-training, software distribution and expanded new services that are becoming available. We also need to continue to expand the quality and conceptualization of instructional materials and make them retrivable to our teachers. If we expect the educational community to use the technology based services, computers, video, the new CD-Rom technologies, desk top publishing, distance learning and the electronic information and mail services that will deliver improved instruction more cost-effectively, the state must continue to provide a leadership and financial assistance to build the enfra-structure of hardware, upgraded facilities, instructional materials and trained teachers so that every student and teacher in California will have access and will actually utilize interactive technologies to their maximum advantage. We must also carefully moniter and document the enhanced learning and cost savings that the effective use of technology in schools will provide. We are confident the AB 803 will be re-authorized in 1988 and that California will continue to provide leadership in infusing technology into instruction.

THE USE OF TECHNOLOGY FOR INSTRUCTION IN THE STATE OF FLORIDA AND BEYOND: CHALLENGE AND VISION

E.J. Lynn*

ABSTRACT

In keeping with the state goal of achieving excellence in education and a desire to prepare students for the world of technology and the information age, school districts throughout the state of Florida, U.S.A., have implemented a variety of computer programs. Writing to Read in kindergarten provides early phonics instruction in many districts while pre-reading computer programs, too, are used for readiness. Word processing and computer assisted instruction are presented in varying formats. Apple and IBM computers now dominate the field, but Radio Shack and Commodore computers, less expensive and with some unique software advantages were the choice early on; many of these are still used. Computer networks now deliver computer assisted instruction in a variety of subject areas; these may use software which is developed by companies according to individual school district's specifications and need, published software which meets generally accepted skills in proper scope and sequence, or published software from various companies which are combined to fit the specific skills identified by a district. Telecommunication, computer Laboratories, in-classroom computers, studies on the most effective use of computers, studies on how computers impact student learning and the student in general, a computer program using interactive videodisc to teach non-reading adults, administrative record-keeping, electronic mail, take-home computer programs, parent computer literacy training programs, and extensive computer training for teachers are only a part of the Florida computer-solution revolution.

INTRODUCTION

Of the fifty states in the United States , Florida has one of the fastest growing student populations. While school districts in states throughout the nation face the dilemma of closing schools because of decreasing numbers of students, school districts in Florida are faced with the burgeoning expense of building new schools and the endless problem of adequately housing students during the interim period. All this growth is occurring simultaneously with a major movement in the state to improve the quality of education by increasing requirements for progression and graduation, standardizing curriculum from the state level, attacking the problems of the dropout, expanding state and local mandates for testing, and, finally, enforcing computer literacy skills mastery for students throughout the state in grades three through eleven. It is this last requirement which has thrust all school districts in Florida into the information age, the age of technology.

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CHALLENGE AND VISION: ONE SCHOOL DISTRICT'S RESPONSE

Of the sixty-seven school districts in Florida, the Volusia County School district is one of the largest eight in the state and is among the largest one hundred in the nation. With a student population of 40,000, this district has assumed a leadership role in the integration of computers into the curriculum. Having committed funding for ensuring the implementation of the writing process in the curriculum beginning in 1982, it was a natural follow-up for the School Board, over a three year period, to implement IBM's Writing to Read program in thirty-four schools, a program which integrates the teaching of reading and writing in kindergarten through the use of computers, phonics programs, word processing software and typewriters. It was at this point (1986) that the need for a short and long range plan for the use and purchase of computers became essential. Once this plan was in place the need for continuity of computer use for word processing precipitated the purchase of almost 5000 computers, five PC Jr's being placed in each elementary classroom and each secondary English classroom in the district; each of the teachers in these classrooms were given one of the computers to use at home for one year. In addition, IBM Model 176 computers were purchased for vocational classrooms, a PC Jr writing lab with thirty computers was established at one junior high school, and similar computer literacy labs were set up at a junior and senior high school.

Computer labs using Apples and some Radio Shack models for literacy and programming had been in junior and senior high schools since 1983. In 1984, Apple computers were purchased for the full time elementary school gifted program. These computers are now integrated into the curriculum through Logo; however, one of their greatest assets is a telecommunication network using the Comp-U-Serve program. Not only do students communicate with each other but they also engage in projects that have involved contact with persons at distant locations whose activities students tracked as part of a math/social studies/ writing interdisciplinary project. This program also provides for extensive research activities.

CORVUS networked computer labs with thirty computers in each have been established at two schools to provide individualized math instruction. Serving low socio-economic students in grades 4, 5, and 6, these labs have resulted in improved motivation and test scores. A federally funded program uses Apple computers and Bank Street Writer to improve language and reading skills. This year the program has added IBM PS 2's for which software has been specially designed to improve standardized test scores. This program and another has also provided opportunities for parents to become computer literate, parent involvement considered an essential part of the successful integration of technology into the schools Each of the fifty-four schools and many district offices now are linked to a district main-frame for attendance, grade reporting and other information; and electronic mail is used extensively

Perhaps one of the greatest challenges continues to be the training of teachers. This has required a three stage approach. First, teachers and administrators were given an orientation to the overall plan for the major installation of 5000 computers that took place over a period of less than one month. Next teachers were given a one day workshop in the basics of the computer; this was followed by workshops held at individual schools to continue the support that was necessary. Classroom assistance and demonstration was also provided as needed. In concert with this training, workshops on the writing process and word processing were held. All of this continues as stage three begins to provide assistance in classroom management techniques which will encourage five computers per classroom to be effectively and maximally used

The need to hire teacher trainers, the need to repair and update computers, the continuous need to stay abreast of software and innovations for improvement; the need to examine and evaluate methods, techniques , and results; and the need to remain flexible enough to incorporate changes: These are the challenges. The vision will be actualized when the computers become so integral a part of education that we do not even know they are there, when "as a good tool it gets out of the users way"(David Thornberg, October 29, 1987 presentation, Daytona Beach,Florida) The vision will be realized when special presentations no longer need to be made about the use of computers in education, when computer literacy is a thing of the past, when educators understand the unique patience and non-threatening interaction which the computer affords students and the new opportunities it provides for teacher empowerment and school restructuring

INFORMATION INTO KNOWLEDGE: LEARNING AND THE CD ROM

Lawrence A. Wiget*

INTRODUCTION

We have reached a new era in education in the United States. It is an era heralded by the introduction of CD ROM (Compact Disc Read Only Memory) technology. CD ROM technology places at the fingertips of the individual up-to-date information on almost any topic. Thus, it has the potential to transform the manner in which we educate our children. However, the key to successful utilization of this new technology will rest in our ability to turn the information it houses into useful knowledge for the learner.

The Anchorage School District, Anchorage, Alaska, U.S.A. has placed CD ROM technology in its Library Resources Department. It has also begun to place CD ROM technology in its schools.

BACKGROUND

In 1981, the Anchorage School District joined the Western Library Network (WLN), a bibliographic utility composed of member libraries located primarily in the Pacific Northwestern United States. In 1982, the District, through its Library Resources Department, began to enter new holdings into the WLN computer system via Hazeltine terminals connected by modem and telephone line to the mainframe computer in Washington State (Scott, 1984).

CD ROM technology was introduced in the first quarter of 1987. The purpose was to facilitate the processing of the more than 100,000 books and audiovisual materials purchased by the District's eighty-six library collections each year. It was also implemented for use in the conversion of any books or audiovisual materials purchased by the District prior to 1982 and which had not yet been placed in the WLN database.

Currently, the District library database on WLN consists of 172,000 records, with an estimated 128,000 titles yet to be added. The majority of titles not entered have copyright dates prior to 1982. Students, teachers and librarians access the database through a microfilm reader. To supplement the limited number of microfilm readers available in the schools, a microfiche catalog was made available to interested librarians in January, 1988. Materials not entered in the database are accessible through the card catalog which was "frozen" in 1982.

LASERCAT

The CD ROM technology used in Library Resources is LaserCat, a product of WLN. It contains the holdings of the Anchorage School District; the Municipality of Anchorage; the University of Alaska; the 294 other contributing members of WLN located in Washington, Idaho, Montana, Alaska, Oregon, Arizona, British Columbia, and California; and, the US MARC records in all formats distributed by the United States Library of Congress with publication dates from the last two years, for a total of approximately 2,255,000 (WLN, 1987). The combined database fits on three compact discs each 4.72 inches in diameter, 1.2 mm thick, with a hole 15 mm across the center.

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LaserCat can be searched by author; title; subject: series; ISBN and ISSN; Library of Congress Card Number; or, WLN Record IDentifier number. One can also conduct exact, keyword, and browse searches for author, title, and subject; truncate search words and phrases; combine two searches; and specify that only those resources with call numbers for one or more specific libraries be retrieved (WLN, 1987).

The hardware and software necessary to operate LaserCat consists of an IBM or IBM compatible personal computer; one color or monochrome monitor; 512 KB random access memory (640 KB preferred); two floppy diskette drives or one floppy diskette drive and one hard drive; MS-DOS or PC-DOS, versions 2.0 or greater; two CD ROM drives, either Hitachi model CDR 2500S /CDR 1503S or Sony CDU-100 external CD ROM, and a controller card; and, LaserCat retrieval software and/or Ultracard/Marc software (WLN, 1987).

LASERCAT APPLICATIONS

As 1987 progressed, personnel at Library Resources and from throughout the District became better acquainted with the potential of LaserCat. Additional applications were undertaken. Bibliographies were run for curriculum coordinators, librarians and other District personnel. Functions previously done via telephone line with the computer in Washington State were now being done less expensively using LaserCat. This included searching for cataloging information for "new to the District" library materials and modifying the holdings field in the database which shows the location within the District of the item. The information was then mailed on floppy diskettes for inclusion in the WLN database and future LaserCat microfilm/microfiche updates.

In the fall, Library Resources successfully downloaded District holdings from LaserCat into the Follett Circulation Plus stand alone circulation system on an IBM compatible computer. This allowed for the potential of Library Resources to interface with the circulation system under consideration for use with the District's school libraries. In addition, labels for library materials were also being printed locally rather than being purchased through WLN or typed manually by Library Resources personnel. Finally, equipment was being put in place at Library Resources to print shelf list cards.

OTHER CD ROM APPLICATIONS

By year's end, Library Resources obtained several other CD ROM packages for use by the department and by District personnel. They included Grolier's Electronic Encyclopedia, Readers' Guide to Periodical Literature, Books in Print Plus, and Bookshelf. The Educational Research Index Clearinghouse (ERIC) on compact disc was also being considered for purchase in 1988.

Of the twelve secondary school libraries in the Anchorage School District, two were implementing LaserCat at the end of 1987. Service High School received one LaserCat subscription and appropriate hardware under a joint grant between WLN and the Fred Meyer Corporation. Chugiak High School, with a new library addition, was installing two LaserCat workstations. The remaining secondary libraries were to receive one LaserCat workstation to supplement their current microfilm readers in the fall of 1987, but the process was delayed due to funding. The LaserCats, along with a Follett Circulation Plus circulation system were expected to be installed in all secondary school libraries in 1988.

Following a recommendation by the library automation committee that the Follett Circulation Plus circulation system be implemented in all elementary libraries in the District, a committee composed of elementary principals and the District Library Supervisor began meeting to discuss the future automation of the District's fifty-five elementary libraries. The automation committee and the principal's committee continued to meet during the winter of 1988 to work toward the goal of total automation for the District's libraries.

THE FUTURE

The Anchorage School District library program has two primary goals in terms of automation. First is to continue a course of action which will allow for completion of our library database on WLN. Second is to computerize the catalog and circulation system of our school libraries. For us, CD ROM technology holds a great deal of promise in these areas at the present time.

Currently, however, with the exception of the LaserCat workstations planned for all secondary schools, CD ROM technology has found its greatest application at Library Resources. Ordering and processing procedures have been enhanced. Librarians and other District personnel are being exposed and trained on a one-to-one or small group basis as to the uses of CD's currently available through the Department. Nevertheless, excitement is mounting concerning the future potential of CD ROM to meet our information needs.

Why is there such excitement for the CD ROM? First, the technology available for library automation is in transition. Because stand alone computers are proving to be more cost effective than mainframes, there is a movement away from using the centralized mainframe computer to using stand alone minicomputers networked from library to library. Second, CD ROM technology allows for the storage of a great deal of information in a very small space with very powerful searching strategies.

CONCLUSION

CD ROM technology is not the only information technology being developed and it is perhaps not the only solution to our information needs in the Anchorage School District, especially needs we have yet to identify. However, it is here today. We are using it in our Library Resources Department and we are introducing it into our secondary school libraries. The CD ROM places before the individual a variety of resources never before assembled in one place in a compact format and in a manner easily accessible. It is an enabling and empowering tehcnology to those that have access to it. It allows the individual to turn information into knowledge.

Scott, Marilynn S. "Technology: Key To Communication For School Library/Media Centers. School Learning Resources. Fall, 1984, 14.

WLN, LaserCat User's Manual. Olympia, Washington: Western Library Network, 1987.

ROBOTICS

R.H. Garvelink*, J.J. Bird**

ABSTRACT

The Birmingham, Michigan, U.S.A., school district has worked diligently to integrate technology throughout the curriculum, from kindergarten through high school, making technology a tool to enhance learning, not a separate curriculum. With the ten year long-range strategic plan adopted by the Board of Education as a guideline, major investments in time and resources have been made to assure the availability of the most appropriate hardware and software as well as expert leadership in staff development.

An excellent example of the commitment is found in the industrial technology department where students are provided an introduction to the fundamentals of these evolving technologies in an intensely practical way through hands-on experiences.

The transformation of the industrial arts department to an industrial technology department was guided by a citizens' advisory committee whose members were carefully chosen based upon the needs of the students and the requirements of the curriculum.

DISTRICT-WIDE INSTRUCTIONAL ACTIVITIES USING TECHNOLOGY

The emphasis of infusing technology into the curriculum has resulted in many changes in instructional activities for our students. Beginning in our elementary schools, students are introduced to keyboarding skills, easy word processing software and basic programming concepts through Logo programs. At the middle school level, computer labs are used to acquaint students to application software. Students learn how to use computers as problem solvers, information processors and data analyzers. One school is experimenting with on-line data retrieval services through the Dow Jones news system. Finally, high school students use computers in many disciplines: word processing for English themes and social studies papers; all of the office data processing functions in business education classes; actual programming activities in math classes including advance placement Pascal; and, the computer-assisted drafting and computer control of machinery in industrial technology classes. Computers are simply an everyday occurrence in the lives of our students.

METHODOLOGIES USED TO DEVELOP THE INDUSTRIAL TECHNOLOGY CURRICULUM

Members of the teaching staff at our high school level responded to the challenge of our Board of Education and the long-range plan to prepare our students for the age of technology by first verbalizing

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a vision for the future and then by assembling the best possible citizens' advisory committee to assist in the implementation phase.

Members of the committee included a college president, a professional writer for technical periodicals, computer experts, a personnel director, engineers from the big three auto companies and a representative from the United Auto Workers. These citizens were able to advise us on the needs of business and industry, identify the most recent technical advances, assist us in obtaining donations of equipment and acted as mentors to individual students.

The challenge of retraining our industrial technology staff was assisted by obtaining several grants which allowed us to pay the cost and salaries of the teachers in a summer program. In addition, time was allocated to work with the counseling staff, making sure they were aware of the objectives of the industrial technology program and also had the best available data in career opportunities and requirements involving technology.

We enlisted the support and involvement of teachers in the English, science and mathematics departments. Our hands-on, problem-solving approach encourages creative thinking but also the need to communicate the findings through effective oral and written communication using appropriate scientific and mathematical notations and terminology. Teachers from these other departments then tutored the students in their respective fields as observations were recorded and results of projects delineated and communicated.

SUMMARY OF CURRICULUM OBJECTIVES IN INDUSTRIAL TECHNOLOGY

The content is centered on the conversion of energy and the transmission and control of power. The emphasis is on gaining an understanding, in a totally practical way, of the physical sciences behind the technologies.

The program is not intended to produce "robotics technicians" or "automation specialists." Instead, the students are being grounded in the fundamentals on which such new job skills, and many others, depend. This grounding comes through the ideal combination of classroom theory liberally accompanied by hands-on experience with the actual mechanisms that convert energy and transmit/control power. The students constantly use, and experiment with, the physical systems that the "real world" employs.

Creativity is encouraged through problem-solving methodologies. Communication and mathematical skills are developed. Students enrolled in the sequence of courses in the study of robotics must master the objectives in air logic, computer programming, electricity and power transmission, which includes the study of mechanical systems, hydraulic systems and pneumatic systems.

RESULTS

The results of having technology infused throughout the school program impacts upon four main client groups and helps perpetuate and sustain further development. Students recognize the relevance of technology in their lives and enthusiastically embrace their learning experiences. Teachers acknowledge the intrinsic need to keep current that comes with the inclusion of technology in their lessons. Parents are appreciative of the fact that their youngsters are getting the latest in pedagogical techniques. Lastly, community leaders, especially those that are brought into the educational system as consultants and experts, quickly lend their support and encouragement. What develops, then, is an expectation to be at the cutting edge, to do more, to be successful.

One such thrust is a consortium of industry, higher education and the Birmingham Public Schools which is bent on improving teacher education programs in the area of industrial technology.

CONCLUSION

The powerful dynamics set in motion as described above can generate a problem, however. That problem is one of systematically planning for the future. How can a school district plan for the future and rise above the natural tendency to be complacent with its accomplishments. One way which has proven to be effective is the convening of a conference which provides a forum through which educators can interact with nationally known futurists. This process was used and was entitled the High School of the Future Conference.

Planners of the High School of the Future Conference decided that the best way to visualize the future high school was to project themselves a few decades ahead, examine what our society and the rest of this global village are likely to look like then, and outline an education that would suit those needs. One of the important considerations involved the balance between high touch and high tech. Various groups had a voice in planning and organizing the conference. Industry and higher education formed a partnership with the public schools to sponsor this meeting. After extensive discussion among members of the planning committee, four themes were selected for study at the conference: 1) demographics, 2) a global perspective, 3) the work place of the future, and 4) the psychology of the future adolescent. To insure that the themes would be approached in a fresh, provocative way, the committee sought speakers who were interested in and concerned about education, although most were not primarily or solely identified as educators.

For three days the conferees wrestled with future concepts and how their schools have to change to meet those challenges. The conference served as a start to develop plans for education in the next century.

USE OF INTEGRATED LEARNING LABS IMPACTS AMERICAN EDUCATION

Dwain M. Estes, Ed.D. *

ABSTRACT

Computer technology is often discussed as the solution to educational problems. But how effective is it? In this paper, the author reviews test scores, educational surveys, and a study on cost-effectiveness to determine CAI's impact on education in the United States.

COMPUTER-ASSISTED INSTRUCTION (CAI) COMES OF AGE

Technology has made its way into the classroom. But what real effect has it had?

In the early days of computer-assisted instruction, users had to choose between stand alone microcomputers or networked "dumb" terminals. Those who chose stand alone microcomputers found little educational software available; those who chose networked instructional systems could not use their computers for anything but the educational software that came with the system. Recently that has changed. Now educators can benefit from the best of both models with an integrated learning system (ILS), which in a networked microcomputer environment, delivers a comprehensive curriculum to students. The ILS is system managed, so student learning is self-paced and interactive, and can be tracked automatically with progress reports.

Technological innovations like the compact disc read-only memory (CD-ROM) have improved the integrated learning system as a cost effective and convenient method for delivering computer-assisted instruction. The CD-ROM has also made it possible for other productivity tools and educational software to be delivered on the network with the comprehensive software of the integrated learning system. Of course, integrated learning system users still may choose to turn off the network and simply use their microcomputers as stand alones.

SCORES RISE WITH INTEGRATED LEARNING SYSTEMS (ILS's)

Benchmarks of the American education system, standardized tests, have been used to measure classroom performance. In recent testing, those students who used an ILS program improved their test scores.

One study by San Diego, California area schools, using Education Systems Corporation (ESC) software shows significant increases in populations with low and high socioeconomic backgrounds. At Martin Luther King School, a school with a history of high mobility and low academic performance, students dramatically improved their scores on the California Test of Basic Skills (CTBS).

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Specifically, the number of fifth grade students ranking with the top half of students in reading rose from 15 percent to 31 percent. For mathematics, the number of students performing in the top fifty percent increased from 26 percent to 41 percent.

At the other end of the spectrum, an affluent suburban school experienced gains in CTBS reading scores. Using percentiles as units of measure, students moved from the 80th to the 98th percentile—a gain of 18 points. CTBS mathematics scores also increased from the 95th to the 98th percentile, a significant increase because gains in the high percentiles are difficult to make. Principals at both schools attributed a significant portion of these gains to the integrated learning systems in their schools.[1]

Other research supports that students of all ability levels learn effectively with computers. [2]

STUDENTS LIKE SCHOOL BETTER WHEN THEY USE THE ILS

Additionally, research indicates that student learning attitudes improve with school use of computer technology, in part because computer education is accepted and well-liked within the students' own peer groups.

A staff paper published by the U.S. Office of Technology Assessment (O.T.A.) supports the argument that computer-assisted instruction is effective because it "enhances motivation for learning, because it can be nonjudgmental, it provides immediate feedback, it allows students to work at their own pace, and it helps raise students' 'status' in their schools." [3]

In a recent survey, parents and students said that they are more motivated to learn with an integrated learning system. Specifically, a majority of parents reported that their children had an improved attitude toward school overall, as a result of working in the computer lab. Most children surveyed also said that the lessons help them do better in their classroom work and help them clarify concepts that were previously confusing.

THE TEACHER BECOMES A MANAGER WITH ILS

In that same survey, administrators and teachers noted that their ILS's curriculum supported their instructional objectives, complements basal texts, and is an active part of their school's instructional program. A majority of administrators also said that their ILS instilled self direction and enthusiasm in students. Teachers also gave the ILS high marks and unanimously reported instructional improvement. Part of this may been due to the high degree of transfer of lab work to classroom activities that almost all of the teachers reported.[4]

Other research supports their comments. In the O.T.A. report, curriculum coordinators "emphasize that the computer is an effective learning tool but that the teacher is not replaced. The teacher plays an essential role throughout." [5]

Still, the role of the teacher is being transformed, from dispenser of information to manager of information. Regular progress reports on how each student is doing help the teacher quickly determine what is being taught in the computer lab, what is being understood, and what needs to be worked on further, in the classroom or in the la—for each student. The reports help teachers get a quick overview of each student's learning progress so they can help students with more individualized learning plans.

THE ILS: A COST-EFFECTIVE WAY TO PROVIDE INDIVIDUALIZED INSTRUCTION

Administrators, teachers, parents and children like computer- assisted instruction and find that it is effective in improving scores and getting results. But is it cost-effective?

A recent study performed at the University of Arkansas indicates that it is. According to Dr. Cecil McDermott, head of the study, CAI is as much as 200% less expensive and more effective than reducing class size and increasing class time to provide individualized instruction.

Additionally, McDermott found CAI to be less expensive per student than hiring a tutor, and only a little less effective.

The cost effectiveness study was based on average gains (grade equivalence) in reading and mathematics resulting from an expenditure per year in each subject and relates to a $3,000 yearly cost of education per student. [6]

Some United States school districts are finding ILS's to be the most cost-effective answer they can provide to special populations, or for special situations. In one very large district, the Little Rock, Arkansas district, 45 ILS labs were chosen as the most effective method of meeting desegregation regulations which required the district to demonstrate a commitment to equitable instruction for all children.

THE FUTURE OF COMPUTER-ASSISTED INSTRUCTION

Computer technology for education has steadily improved in the areas of curriculum quality, improvements in color and sound quality and adaptation to other computer hardware technologies. And those improvements are likely to continue.

So, how will a steadily improving CAI impact the future of United States education? The anticipated teacher shortage will be met through CAI. The role of the teacher will change to that of a facilitator. Teacher shortages in such areas as mathematics, science and bilingual education will be overcome by master teachers working with larger groups with the aid of technology.

Educators also will get serious about providing for individualized instruction, helping students to maximize time on task, and controlling time spent on attaining the district's and state's curricula objectives. CAI will enable these things to happen.

CONCLUSION: TECHNOLOGY MAKES SCHOOL APPLY TO LIFE

Computers are not the panacea for all educational problems, but they will become an increasingly important resource for solving educational issues. What American educators have realized is that if they want to make what is learned in school applicable to the lessons of life, then they need to do more than nod their heads at technology. ILS's are one way American educators are making a commitment to the technological world their students increasingly live in, while still encouraging equity and excellence in learning.

ENDNOTES

1. "Test Scores Rise Significantly For Diverse Student Populations Using Education Systems Corporation (ESC) Courseware" (San Diego, California: Education Systems Corporation, 1987).

2. Trends and Status of Computers in Schools: Chapter 1 Programs and Use with Limited English Proficient Students (Washington, D.C.: U.S. Congress Office of Technology Assessment, Science, Education, and Transportation Program, 1987), 10. 3. Ibid, 9.

4. "Administrators and Teachers Overwhelmingly Enthusiastic About Education Systems Corporation (ESC) Computer Labs" (San Diego, California: Education Systems Corporation, 1987).

5. Trends and Status of Computers in Schools, 9.

6. Cecil McDermott, Assessment of Technology-Based Supplementary Instruction (Cupertino, California: Apple Computer, Inc.), 51.

THE "WHY" AND "HOW" OF COMPUTERS AND LEARNING

Nolan Estes* and George E. Uhlig°

ABSTRACT

The microcomputer "revolution" is often dated from June 5, 1977, when the Apple II was introduced to the general public. The past ten years has seen the literature concerning the teaching/learning process expand substantially in the area related to information technologies generally and microcomputers specifically. Although there have been critics of the movement, most projections and observations have been optimistic. Based upon research on and observation of the use of computers by students from first grade through college, the authors posit the following assertions concerning the "Why and How" these technologies will improve learning: (1) Technology increases "time on task." (2) Technology increases the effective use of the time on task. (3) Technology provides new ways of accessing and manipulating information and data. (4) Technology provides new ways to present and understand data and information. (5) Technology will improve the quality of individual learning. (6) Technology will improve student academic progress assessment and reporting, and increase teachers' efficiency.

INTRODUCTION

The microcomputer "revolution" is often dated from June 5, 1977, when the Apple II was introduced to the general public. As a consequence the past ten years has seen the literature concerning the teaching/learning process expand substantially in the area related to information technologies generally and microcomputers specifically. Although there have been critics of the movement, most projections and observations have been optimistic. It appears timely to summarize the technological movement in the classroom in terms of how it can and will impact upon the teaching/learning paradigm, and why it does so. Understanding the "how" of the issue, it seems to us, requires a discussion of "why" technology can increase learning effectiveness. In our research on and observation of the use of computers by students from first grade through college, we believe the following assertions can be supported.

TECHNOLOGY INCREASES "TIME ON TASK"

We have found that students, generally, are willing to devote more time to keyboarding and other related activities than they are to the traditional methods. As the computer becomes more and more affordable and portable, and students routinely have access to one at home or in their living quarters, it seems reasonable to assume that the amount of "time on task" will continue to increase. A number of institutions have recognized this. This fall (1987) Lehigh University will provide RJ-11 telephone jacks in every dormitory room and students will be able to link into the University and external data bases 24 hours a day. Much research, particularly by the International Olympic Committee but also by others, has shown that individuals operate on different biological clocks. In common parlance, there are "morning people" and "night people". The IOC calls them "larks" and "owls". Most libraries are designed for "owls". Twenty-four hour information access will serve all types of biological clocks and working styles.

TECHNOLOGY INCREASES THE EFFECTIVE USE OF THE TIME ON TASK

One good example of this is word processing, where the actual final copy/ reproduction time is reduced, and the ease and effectiveness of the outlining, revision, and editing is substantially increased as is the amount of time available for these activities.

Consider how "library research" was conducted twenty years ago. The time available to complete a library research project might have been divided into the following categories: (1) Identification of problem, (2) Library search of relevant reference texts and periodicals, (3) Analysis and synthesis of selected references, (4) Initial draft, (5) Revision, (6) Final draft.

Depending upon the individual researcher's resources, the availability of a typist, the quality of the local library, etc., a large amount, in some case an inordinate amount, of time would have to be devoted to the library search, drafting, revisions, and final draft typing. With computers, word processing, and telecommunications making

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on-line reference searches faster and more complete, a greater porportion of time is available to the two most important research activities: identification of an important, relevant problem, and careful analysis and systhesis of selected references.

It is also evident in experiments with data sets in which, through the use of a statistical analysis package or a spread sheet, variables can be changed easily and the effect of the change on the final distribution or result observed immediately. "What if" analyses can be carried out repeatedly.

TECHNOLOGY PROVIDES NEW WAYS OF ACCESSING AND MANIPULATING INFORMATION AND DATA

An important example of this facet of the new information technologies is the ability to access, search, and reproduce electronically and finally in printed form data from a wide range of data bases accessible by a telephone call through a computer and modem, or from CD-ROM and videodisc formats. The BBC-sponsored Domesday Project is an excellent example of how national census data and related health, economic, educaitonal, and governmental information can be combined and made available to schools, business, industry, and government in an inexpensive and flexible format.

The British Domesday Project is particularly interesting. Several years ago, to celebrate the 900th anniversary of William the Conqueror's original Domeday Book, the British Broadcasting Company decided to do a comprehensive, exhaustive census of the United Kingdom using the most modern of available technology--interactive videodisc. The effort resulted in two remarkable discs.

One disc was developed with heavy involvement of the British schools. The United Kingdom was divided into 3 by 4 kilometer rectangles, and in each rectangle a fifth grade class was asked to (a) submit four photographs of activities, events, landscape, strutures, and the like which they felt really represented the area, and (b) to write stories, letters, descriptions, and the like about the section. Three of these photos and various written descriptions were included in the disc. The second disk included a vast array of census data sets including housing statistics, educational data, health and safety statistics, television viewing statistics, transportation information, and the like.

The discs open with a satellite-based view of the total Kingdom. This large scale map is divided into 30 by 40 kilometer sections, each of which is further divided into 3 by 4 kilometer section as mentioned above. Since the disc is interactive a variety of activites can be performed. For example, with a light pen a geographical section of a portion of the nation can be identified on the screen. (This need not be one of the predefined sections, but can overlap sections, or be portions of small sections.) Then questions about the section can be asked. For example, "How many 16 year old school leavers are in the section, how many were boys, how many girls, and how many left school for health reasons?" Now the software goes to work on the data bases which are encrypted on the videodisc and builds, on the screen, bar graphs representing the data necessary to address the questions. The Domesday Project discs are enormously popular as educational tools; but they are also on demand by market research firms because of the completeness of the data and the ease and flexibility with which the data can be massaged to answer specific marketing questions.

TECHNOLOGY PROVIDES NEW WAYS TO PRESENT AND UNDERSTAND DATA AND INFORMATION

The ease with which, for example, numerical information can be presented as statistical estimates, line or bar graphs, scattergrams, etc., will have the effect of maximizing the understanding of numerical concepts. Numerical estimation, an important thinking and processing skill, can be practiced and enhanced effectively using microcomputer hardware and software. Moreover, the use of program such as LOGO and LOGOWRITER at the early elementary school ages will provide younger and younger students with insights into arithmetic and geometric constructs than ever before possible in this culture and society.

TECHNOLOGY WILL IMPROVE THE QUALITY OF INDIVIDUAL LEARNING

There are a number of characteristics of the technological interface and capability which will relate to the improvement of the quality of individual learning. One of these include ease and accuracy of identifying mistakes or possible mistakes through the use of spelling checkers, grammar analysis software, and the like. Computer Assisted Instructional software will provide immediate feedback and a process for identifying areas of learning strengths and weaknesses.

Early keyboarding skills will develop a generation of learners who are comfortable with the technology and facile with information entry.

The increased use of LOGO, particularly at the early elementary school level will enhance spatial reasoning skills, problem solving ability, geometric and arithmetic understanding, and, probably paired or group problems solving skills.

Computers and interactive video will provide reinforcement for non-linear thinking, and the availability of inexpensive, light weight video cameras will provide students at every level to become producers of information, as desktop publishing hardware and software, and peripherals such as digitizing devices will make every classroom a potential "publishing house". The John Dewey philosophy of 'learning by doing" will be able to be tested in an academic arena.

For the past two years we have been working closely with a group of first graders and an excellent first grade teacher on a research project to explore the differential effects of Guided Discovery LOGO. As an educational researcher and measurement specialist by training, and an information technologist by preference, we try to observe the technologically-rich classroom environment in a manner which addresses two questions:

WHAT IS TAKING PLACE? HOW CAN IT BE MEASURED?

To understand what we have concluded about the effects of Guided Discovery LOGO on first graders, it is useful to understand what the strengths of LOGO are purported to be, what Guided Discovery LOGO is, and specifically how Guided Discovery LOGO differs from other instructional models of LOGO.

LOGO, as designed by Papert and his associates, is both a programming language and a philosophy of education. As a philosophy of education, Papert envisions a LOGO-rich (and hardware-rich) environment is which children control the LOGO turtle and, consequently, the computer and in which truth, relationships, understandings, and cause and effect relationships are "discovered" with no formal instruction by a teacher. Generally, this approach is described as "Discovery LOGO", and the importance of the teacher is very limited.

As a programming language, LOGO is a powerful list processor but one which has been designed to be easy to learn and motivational for even the youngest school-aged students. In programs where LOGO is viewed as essentially a programming language, instruction often takes place much as it would with BASIC, FORTRAN, PASCAL, or any other top-down, structured language. In fact, in Structured LOGO, there tends to be one best or "most elegant" solution to a problem and the instructor plays an important role.

There is a moderate position between these two extremes which is usually described as Guided Discovery LOGO. In Guided Discovery LOGO, the teacher's role is to suggest, encourage, offer alternative solutions, and, in some cases provide direct instruction when it is needed. Guided Discovery LOGO has the distinct advantage of being a useful approach in learning situations where less that a "LOGO-rich" environment exists. In these cases, where the number of computers is limited, or where access to hardware in a computer lab is restricted, Guided Discovery LOGO appears, at least to us, to be a very useful approach. In our research on first graders with Guided Discovery LOGO we have emphasized a number of pre-LOGO and pre-Keyboarding activities. These activities have been designed to complement and supplement the actual and limited keyboarding time the students have. These activities are designed to increase understanding of the concepts of left and right, to increase keyboarding facility, and to enhance listening skills. Teacher made materials include a simulated keyboard, hand puppets made in the shape of a turtle, a turtle board game in which turtles are made of half English walnut shells, and dances and other body movements to enhance left-right discrimination (such as the Hokey Pokey). We also placed one microcomputer in the classroom as a "learning station" and used programs such as MECC's Right-Of-Way to enchance both keyboarding skills and the understanding of left and right.

There is a phenomena in most classroom-based research which is ordinarily called "teacher effects". "Teacher effects" are important because in most field-based research, randomization of treatments, groups, and subjects is often important and efforts to control for the impact of differences among teachers often lead to such complex designs that full implementation is impossible. When teaching about "experimental" and "quasi-experimental" designs, we often quote Bachrach's First Law of Psychological Research: **"People do not usually do research, the way people who write books about research, say that people do research!"** Consequently, and particularly with Guided Discovery LOGO in which the teacher plays a key role, teacher effects must be considered, and we have no assurance that the differences we found are not a direct result of the teacher's ability and enthusiasm, or an interaction between the teacher and the Guided Discovery LOGO procedure, a procedure which the teacher understood in depth and believed in enthusiastically.

The experimental treatment consisted of one hour per day of Guided Discovery LOGO for a period of 16 weeks. Dependent variables included mathematical readiness as measured by the Peabody Mathematics Readiness Test, visual-motor development as assessed by the Beery Visual Motor Integration scale, attendance, and achievement on various subtests of the Stanford Achievement Test. The PMRT and VMI were administered to the experimental and control groups by the investigators' staff; the SATs were administered by school personnel. Attendance was compiled from existing records.

The results have been published elsewhere (Robinson, 1987; Robinson and Uhlig, 1987; Robinson, Uhlig & Gilley, In Press)and without going into extensive details, the experimental group was found to have significantly higher scores on the total PMRT, the VMI, the SAT subtests of Mathematics Concepts and Computation, Vocabulary, and Listening Skills, and evidenced better attendance during the treatment period. After the experimental treatment period, the experimental group moved into word processing using IBM's Writing Assistant program. There have been other reports which tend to substantiate our findings. Clarke, for example, found that experience with Guided Discovery LOGO significantly increased School Ability Index scores of elementary-aged girls. Can our observations help explain these results? We think they can.

First, particularly for elementary school youngters, computers are motivational. They are "fun"! The computer in the classroom and in the laboratory provides a focus for learning which most teachers cannot replicate for several reasons: first, with the ratio of two or three children to one machine is more effective that twenty or thirty children to one teacher. Second, Guided Discovery LOGO, at least in the form we have used it, requires and enhances specific skills and knowledges. Very important among these are listening skills. As the teacher provides hints or direct instruction concerning the LOGO lesson, two things happen. First, the student is motivate to listen in order to facilitate controlling the turtle. Second, failure to listen or to understand provides immediate feedback to both the student and the teacher. If the screen does not change, it is a signal that the student did not follow directions. The student knows it immediately and so does the teacher. With regular desk work, often neither the student or the teacher ever knows that a lack of understanding exists. Third, Guided Discovery LOGO includes a number of learning activities which are central to the elementary school curriculum, ranging from concepts of directionality and handedness (left and right) to shapes to colors to vocabulary, to letter and word recognitions, to keyboarding and creativity. We are also fnding (or at least suspecting, we have not researched it yet) that the 2:1 student/machine ratio increases cooperative behavior and develops social interactive skills.

We have also found in each of the two classes we have worked with that there is at least one "techie". This is a five, or six, or seven year old who, almost intuitively, knows why something does not work, how to trouble shoot it, and how to repair it. It is unlikely that the oridinary first grade classroom would identify or reward individuals of this type, much less use them to increase instructional effectiveness and as models for other students.

TECHNOLOGY WILL IMPROVE STUDENT ACADEMIC PROGRESS ASSESSMENT AND REPORTING, AND INCREASE TEACHERS' EFFICIENCY

There are many examples we could report here, but we will dwell on just one. In our district, testing and reporting requirements are demanding. Some might argue that they are unreasonable. In any event, we placed a Macintosh Plus, a printer, and a variety of software in one classroom to be used by two teachers. The first task we tackled was the grade book. Now there are a variety of software packages designed specifically to serve as electronic gradebooks. After reviewing these at some length we decided a more generic approach would be useful and we selected Multiplan. (We would have selected EXCEL if it had been immediately available, but since it was not, and Multiplan was, we selected Multiplan.) After about one hour of instruction, we had the two teachers entering and averaging data, copying rows and columns, and experimenting with computational formulas. Within two weeks of occasonal use, one teacher found that immediately before a parent conference she could copy the student's record to a new row, then compute and copy the class averages for all of the columns to a second row, and print out a spreadsheet which could be shared with and given to the parent during the conference. Such a procedure saves the teachers time, is more accurate than copying by hand, and tends to demonstrate to the parent that these records are "official". Moreover, the teacher can share information with the parent without violating the rights or privacy of other students.

REFERENCES

Robinson, M.A. The Effects of LOGO Instruction on the Perceptual Motor Integration and Mathematical Readiness of First Grade Students. MS Thesis. Mobile: University of South Alabama. (1987)

Robinsion, M.A., Feldman, P. and Uhlig, G. E. The Effects of LOGO in the Elementary Classroom: An Analysis of Selected Recent Disseration Research (1987) Education, 107, 4, pp. 434-442, Summer, 1987.

Robinson, M.A. & Uhlig, G.E. The Effects of Guided Discovery LOGO on Mathematical Readiness and Visual Motor Development of First Grade Students, Journal of Human Behavior and Learning (In Press).

Robinson, M.A., Gilley, W. F. & Uhlig, G. E. The Effects of Guided Discovery LOGO on SAT Scores of First Grade Students. Submitted to The Computing Teacher, December, 1987.

WHO MOVES - CLASS OR COMPUTER?

DERYN M WATSON *

ABSTRACT

Despite widespread provision of microcomputers in UK secondary schools, their use across the curriculum is only now being fostered both by government agencies and curriculum bodies. Software is increasingly seen as having a potential to support and enhance curriculum initiatives based upon a conceptual understanding and the development of process skills. This growing relationship between microcomputers and the curriculum is threatened by the introduction of networks in schools. Their physical location and management can produce an inhibiting environment that will threaten the very innovations that they meant to herald.

INTRODUCTION

Microcomputers are now an established resource in schools in the UK, following the twin thrusts in the early 1980's of two government agencies, the Department of Education and Science (DES) with its Microelectronics in Education Programme (MEP), 1980-86 (1), and the Department of Trade and Industry with its matched-funding schemes for Local Education Authorities, for purchasing hardware, peripherals, modems and software (2). Significant attention is now being focussed on their use - are they simply a facility for computer studies or 'computer awareness' courses, or are they relevant for a variety of curriculum aspects within the school?

CURRICULUM RELATIONSHIP

The director of the new DES Microelectronics in Education Support Unit (MESU), John Foster, said in 1986 "There has probably never been an educational idea that has been taken up so quickly and so widely as was the use of computers in our schools. However they are still nowhere near fulfilling their potential. They are too rare and too special". (3) Her Majesty's Inspectorate (HMI) reported, after a survey in 1983-6 that "in secondary schools, although an increased awareness of IT became apparent it was still the case that, outside specific computer and electronics courses, IT was rarely used". But they also stated that "where secondary school teachers were using microcomputers in various subject studies, with good software and appropriate support materials, pupils' learning was often enhanced." (4).

At the same time, (1986) the DES commissioned a series of documents from the subject associations on the impact of new technology on the teaching of their discipline. A variety of these, including those for English (5), Geography (6), and History (7) teachers, reflected that microcomputers in secondary classrooms are in some cases supporting an already significant shift in approaches to teaching and learning. This shift was heralded by the work of some major national curriculum projects (8, 9, 10), by the new GCSE examinations (11) and HMI (12). The current national policy

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espoused by the DES and MESU is to emphasise inservice education and advisory provision, in order to foster a closer understanding of the use of computers across the curriculum.

The increased curriculum emphasis on discovery and enquiry based learning can be enhanced by the use of computer simulations and data interrogation packages. In order to maximise this potential, pupils are often organised in groups (13). Initially used as a method to overcome scarcity of hardware, the active involvement in learning, group communication and decision making around the keyboard have been reported by Cummings (14), and Chatterton (15), as an additional benefit to the problem solving and hypothesis testing approach fostered by some educational software. Hurd (16) reports from a major national survey that CAL users are likely to have a prior disposition towards active styles of learning including group work.

HARDWARE CONFIGURATION

Paradoxically this imaginative use of the micro, which supports new curricula approaches with an emphasis on conceptual understanding and process skills (17) is threatened by the advent of improved technologies, and in particular of networks. There is, I believe, a considerable danger that networks and the environment that they encourage, may harm the working relationship that is being fostered between new educational methods and the new information technologies.

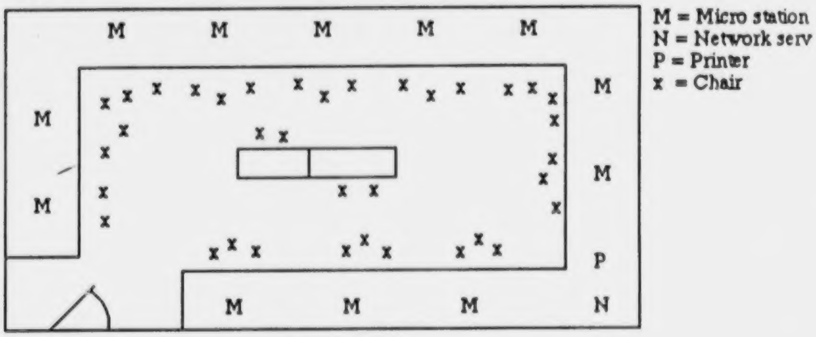
With a stand-alone system, the micro becomes an easily managed resource such as a video, tape recorder or film-strip projector. The robustness and portability enables the teacher to locate the machine in the classroom where the curriculum is being delivered, its use can be incorporated into the whole class framework, rather than a special separate activity. With one machine however, the potential is limited; with 6 stand-alones, flexibility of styles of use can increase, but the physical management of multiple copies of software may begin to become burdensome.

Networks should mean an expansion of computer provision in terms of power and availability within schools; they should be able to support a variety of organisational styles. In reality they are too often encouraging the establishment of computer rooms - a timetabled fixed resource. Figure 1 represents a typical computer resource room, that now exists in many schools. Let us explore this environment in more detail.

In order to use this room, the teacher will have to book it as a central resource well in advance. This means that whatever happens, they must use the computer on Wednesday, period 5 with class 3B, because that is the time they can have access to the resource. The class has to move from their normal classroom; they will have to take any other resources they may need, e.g. Atlases, worksheets.... with them.

A geography class, for instance will be moving into a totally different style of environment. On the wall will be some IBM posters, notes on how to connect a printer, and possibly a few logo drawings, such as endless circles. But where are the maps, charts, photos and pupils work that make up the displays in a typical geography classroom? All this will suggest to pupils that using the computer is a separate activity, that is different from their real geography lesson. It does not encourage a sense of integration; the nature of the room emphasises the

Figure 1. The typical layout of a computer room.



hardware, not a learning environment, to be generated by the software.

The physical arrangement with micros on benches around the walls inhibits the teacher-learner relationship. The pupils sitting either alone or in groups around the keyboard are facing the walls. When teachers want to address the class or group of pupils, they talk to their backs; it is an environment that changes the physical relationship for a lesson.

Teachers with one or a few micros in their classroom would have and load the software themselves; with a networked computer room the software will be on the network server. The teacher may have to check with the computer manager details such as whether the program is still located on the same file, if the user number/access point is the same. The teacher may well have to wait for the computer teacher to unlock the room and load the software, before she is once more in charge of her own lesson. All these factors create a distance between the teacher and the class; but they also remove from the teacher the sense of control over her resource and lessons.

Tying down micros by networks have removed the control of the resource from the teacher responsible for the class, and placed it in the hands of the network manager, whose methods of organising the user access and interface of the network may reflect a "computer centre" perspective rather than an educational one. The problem that I myself have with our increasingly networked resources at King's, is that I am encountering the same alienation that I last felt when working in the mid-seventies on a mainframe. I feel distanced from the resource; I no longer feel in control; files change location and name without reference to the users, the interface and initial search menus assume an understanding of the hard disk locations; my access now depends on others.

In the 1960's in the UK there was a renewed emphasis on modern language teaching in the newly formed Comprehensive Schools. Many language laboratories were built and equipped, but today language laboratories play little part in modern language teaching. They displayed all the problems of networked computer rooms - they were a fixed timetable resource, the pupils sat with their backs to the teacher facing the machine and it also has to be admitted that the quality of much of the tapes was dire in educational terms. Today, teachers use portable cassettes in their normal language classes.

CONCLUSION

There is of course no need for networks to be equated with fixed computer resource rooms or insensitive management. But in reality, this is what is happening. The person in charge of the network, who is a key to the way the facilities are used in the schools, will often be from a computer science background whose whole ethic will veer towards a computer centre. In essence therefore the current spate of networking in schools is in danger of inhibiting rather than encouraging a diversity of use and confidence in the power of the resource. If information technologies are to be one of the various influences that enhance, extend and change the curriculum, then a return to the mentality of central resource provision similar to mainframes in the sixties is to the detriment of innovation.

REFERENCES

1 Richard Fothergill, The Microelectronics Education Programme - a strategy. DES, 1981.
2 Department of Trade and Industry, Micros in School Scheme. DTI, 1981.
3 John Foster, The Microelectronics Education Support Unit, Introductory pamphlets, 1986, p.7.
4 Department of Education and Science, HMI Report. Aspects of the work of the Microelectronics Education Programme. DES, 1987, p.44.
5 NATE, English Teaching and the New Technology : Intro the 1990's NATE, 1987.
6 Geographical Association, The Role and Value of New Technology in Geography. Ed. Fox, P., and Tapsfield, A. GA 1987
7 Historical Association, New History and New Technology, Ed. Blow, F., and Dickinson, A. HA, 1987
8 Economics Education 14-16 Project. Project Director - Raymond Ryba, Manchester University Department of Education.
9 Schools History 13-16 Project. Project Director - Ian Dawson, Trinity and All Saints College, Leeds.
10 The Geography of the Young School Leaver Project; the Geography 14-18 Project; the Schools Geography 16-19 Project. Contact, Geography Association, Sheffield.
11 GCSE Examination : Secondary Examination Council with Open University. Guides for Teachers.
12 HMI. A View of the Curriculum. DES 1980
13 D.M. Watson, Developing CAL; Computers in the Curriculum, Harper and Row, 1987.
14 R Cummings, Small group discussions and the microcomputer. Journal of Computer Assisted Learning, Vol. 1., No. 3 1985.
15 J.L. Chatterton, Evaluating CAL in the Classroom, in Teachers, Computers and the Classroom. Eds. Reid, I., and Rushton, J., Manchester University Press, 1985.
16 S. Hurd, Computer use in Economics, in Kent, W.A., and Lewis, R. (Eds) Computer Assisted Learning in the Humanities and Social Sciences. Blackwell Scientific Publications, 1987.
17 D. Watson, Software to encourage learning, in Ramussen, B., (Ed). The Information Edge; the future for educational computing. Queensland Educational Computing Group, Brisbane, 1985.

PHYSIO-FITNESS--ULTRA PHYSICAL EDUCATION--WELLNESS AND TECHNOLOGY

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ABSTRACT

Since the major problems of our society are lifestyle problems, it becomes imperative that a major emphasis in education is focused on the health development of our youth. To accomplish this goal, two distinct segments must be presented in the format of all physical education classes--a wellness segment that addresses specific areas of health-related fitness at specified time intervals, and an activity segment.

INTRODUCTION

Preventive health attitudes can be encouraged by ADDRESSING the key health problems through a well-designed program and then requiring a full technological health assessment conducted for every child each fall and each spring. These extensive assessment conducted should provide students visual feedback using the latest in technology. No longer can we afford to address the health problems of the 1990s using methodologies and technology of the 1950s. Results from fall to spring show 87% of the entire student body has attained average or above cardiovascular fitness each of the past five years. Posture Efficiency exercises have the potential to represent fewer back problems in future years.

METHODS

Schwinn ergometers, Puma Computer Shoes, Quantum Sport Tester Heart Monitors, Microcomputers, Gravity Oscillating Machines, Digital Sphygmomanometers, Computerized Skin Calipers, and Biofeedback Labs with Electrode sensors are some of the sophistication involved in a physical education program for the future.

A measurement of the success of this program centers on the development of the self-concept within each student. The self-concept of each individual relies on the exceptions and accomplishments that are possible for that person. The four avenues that the self-concept can be developed are: ***mental development, skill awareness and improvement, emotional and social development, and health development.*** This provides every student the equal chance for success in each physical education class. Evaluation is measured by attitude, effort, and awareness according to the expectations for that student. The classes have the climate for success and provide each student with the knowledge and skills for quality living.

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The goals through Ultra Physical Education for all students are:

1. to be educated in the principles of fitness.
2. to attain an average or above level for health-related fitness.
3. to fully participate in each one of the eighteen activities provided and demonstrate improvement (skill awareness if not skill acquisition).
4. to exhibit positive attitudes that can accept differences in others with encouragement to all.
5. to grasp the necessary knowledge to provide a balance to the individual's fitness and activity interest.

The wellness and activity segments overlap the mental and social development and provide for growth opportunities that should enhance the student's self-concept. To accomplish the goals of the Ultra Physical Education, the class format is broken down into three basic time segments: gravionics, aerobic development, and activity/skill development.

Health-related fitness and skill-related fitness must share the same degree of emphasis in the regular physical education classes. When the graduated students are free to choose a fitness life-style, they have had the experience and the education necessary to safely plan and pursue a level of personal wellness. The curriculum will have provided a variety of experiences and the necessary consistency required to achieve total fitness. This will result in a pattern for total wellness now and for the future.

Evidence of the program effectiveness is objectively determined by the health-related assessments given in the fall and spring of every year. Individual improvements are noted in many categories fall to spring. The clearest evidence in improvement noted is in the cardiovascular condition. For each of the past five years, there has been eighty-five to eighty-eight percent rate in average or above average cardiovascular condition each spring. The test used is the Astrand Condition One Step Test using a Schwinn ergometer and a microcomputer heart monitor that visually displays the heart rate and graphs the heart rate in print. The use of heart monitors and ergometers utilize a safer and better awareness feature for the cardio-fitness.

ULTRA PHYSICAL EDUCATION
"A Climate For Success"

Physical Education has entered the Age of Preventive Health

Strategies
Spectatoring
Stress Management
Rules Knowledge & Application
Mental Toughness
Positive Thinking

MENTAL
*
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HEALTH * * * * * * * * * * * * * SKILL
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EMOTIONAL

Health Problems

Drugs
Cancer
Heart Disease
Stroke/Circulatory
Back Pain
Smoking
Stress Mismanagement
Diabetes
High Blood Pressure
Eating Disorders
Malnutrition
Spinal & Joint Problems
Heredity Diseases

Control
Sportsmanship
Expresssion/Socialization
Interaction and Participation

Activities

Sports
Recreation
Games
Outdoor
Dance

HEALTH ASSESSMENTS--------Positive Living--------SKILL-RELATED FITNESS
(Wellness) (Physical Education)

1. Cardiorespiratory (Ergometer/Heart Monitor)
2. Pre-Exercise Heart Rate (Quantum Heart Monitor)
3. Recovery Heart Rate (Quantum Heart Monitor)
4. Blood Pressure (Sphygmomanometer)
5. Lung Volume (Spirometer)
6. Body Fat Percent (Skin Calipers)
7. Posture Efficiency (Martin Posture Assessment)
8. Stress Awareness (Biofeedback)

Health Awareness is Lifestyle Awareness!

1. Agility
2. Balance
3. Speed
4. Reaction Time
5. Power
6. Hand/Eye Coordination

Life Important Goals?

The Interactive Management of a Developing Information Service

Sally Fearn, Publicity and Information Officer, SCET *

ABSTRACT

The rapid uptake of new information technologies in schools has created an unprecedented demand for support and information. At the same time, the equipment now available in many schools is providing the potential for a revolution in the methods of information dissemination.

While not losing sight of traditional methods in which many teachers have confidence (word of mouth, printed documents, etc.) SCET has, for several years, been investigating electronic ways of sending information to educational institutions throughout Scotland. The result is a complex system of information networks mixing new and traditional methods to bring together information related to new technology and the people who use and produce it.

INTRODUCTION

New information technologies have created new demands of the education system. Rapid research and development has been necessary with users hungry for the resultant information. People from unlikely backgrounds are being brought together such as computer suppliers, programmers and educationists, all in need of information held by the others.

This presents an information service with the challenge of finding new ways of handling this new rapidly changing information. At SCET we see the information service as having a major role in facilitating communications. It is a dynamic part of the process of developing the use of new information technologies within education, drawing together interested parties.

INFORMATION HANDLED

The main areas of interest cover hardware, software, educational policies, training and who is doing what. Some typical hardware enquiries have been: what computer should I buy?; where can I buy a Macintosh and at what cost?; and how do I connect my computer?

Software enquiries cover compatibility issues and availability issues, such as: what good physics software for secondary schools runs on the BBC micro? and do programs which run on the BBC B also run on the Master?

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There are also enquiries about software not working: often this is for a simple reason, such as the write-protect sticker not having been removed. Other enquiries include: do you know anyone using a computer for X (a specified topic)?; where can I find computer awareness training?; and what are the future plans for SCET software development?

PLANNING

It is clear that information required to answer these questions becomes rapidly out of date. New hardware and software come on to the market and the range of teacher expertise widens. In Scotland, educational policy for our 860,000 pupils is determined centrally by the Scottish Education Department (which also largely funds SCET). The administration of public-sector education is carried out by local government's nine Regional and three Island Councils. Strathclyde Region, as the UK's largest local authority, is sub-divided into six Divisions.

Recently new policies and plans have been devised. A National Plan for Microcomputers in Schools was published by SCET and local authority Plans have been developed. This has had two effects on the SCET information service. The first is that it is easier to answer many enquiries: people are encouraged to fit in with local policies when purchasing hardware or software. The second is that the information service needs to know what these policies are.

METHODS OF INFORMATION DISSEMINATION

While some people are now able and keen to use electronic systems, many still will not, for a variety of reasons. This means that a range of methods are used to collect, sort and disseminate information.

Word of mouth is probably the most effective way of finding things out - as delegates may agree. When I ask teachers how they found out about a program, the answer is frequently that they asked a friend or their Adviser.

SCET Officers talk about SCET resources (mainly software, packs, publications, videos) and activities (workshops, research and development) to individuals at conferences and exhibitions; SCET is beginning local 'events' throughout Scotland, to spread the word, and has organised events at SCET both for Scottish and international audiences. In all these cases, the information exchange is the key - SCET finds out what others are doing and what information needs are as well as giving out information. Also, a telephone enquiry service is run.

The local Authority Computing Advisers are important contacts for SCET, which holds regular meetings with them, College of Education Computing lecturers and the Curriculum Development Service, to exchange information. Computer manufacturers or software publishers are often invited to give informal presentations to this Information Forum. In this way, Advisers are armed with current information and manufacturers' plans and are more able to help with the formulation of local policy and to advise teachers. It also gives them the opportunity of telling manufacturers of the needs of education.

Through the Information Forum, reduced costs for bulk purchase of software has been possible, with the side effect of some packages being widely used in Scotland. This has led to a limited standardisation of software used, enabling users to exchange ideas about usage and apparently increasing confidence in the use of these packs.

Members of the Information Forum also distribute SCET software locally as well as carrying out a range of local development activities. Members are seen as vital links in a two-stage process of software and information provision. Information supplied by other sources, such as the list of available computing courses compiled by the Microelectronics Educational Development Centre at Paisley College of Technology is sent to the advisers for use in answering local enquiries. This dissemination process assists greater local support for teachers.

Written information is given by SCET in its journal "Micros in Scottish Education" which enables educationists to communicate their developments. The articles contained range from discussion documents to news items including articles from teachers describing their use of computers in classrooms. As the written word becomes rapidly outdated, in many cases information is disseminated through shorter-term publications such as newspapers and journals rather than books.

It is noticeable that the life-span of some information in this area is increasing. As standards are devised and software becomes an integral part of courses, case studies, software information and evaluations and educationally-led research are becoming more durable. For these, more traditional methods of information handling are possible. SCET is now establishing a Computer Software Information Service which is gathering information, sorting it (using various criteria: subject, machine, age,) and using this information to answer many of our software enquiries. This process was not practicable in the past: software had a shorter life-span, as did software publishers, and much software information was obtained by word of mouth, from friends, advisers and, at exhibitions, from publishers.

Many schools in Scotland now have the capability of accessing **electronic systems** and SCET is using three systems for communicating information.

On **Prestel**, British Telecom's public viewdata service, we have a database giving a range of information about SCET activities, services, resources, etc., some of which covers news and other dynamic information (new software, workshops and conferences) and some is longer term. The system is bright, as reliable as the information provider is, easy to use and can be used to order resources and send messages. It is easy for SCET to update and edit as we house a Prestel Umbrella Information Provider service and have in-house editing facilities. The database is contained within the Education section of Prestel, where users will find a wealth of other valuable educational information. They can also explore the main database for use as an educational resource.

Staff at SCET have built up a particularly valuable database of special needs information on Prestel, called SEND: the Special Educational Needs Database. It covers hardware, software, publications, developments, contacts and courses and conferences. It also offers a noticeboard, response pages and the mailbox facility. This is a prime example of a success story in rapid information provision: the users frequently provide the information which is incorporated into the system for other users.

Another system used by SCET is **TTNS** (The Times Network Systems). A subsidiary of News International plc., TTNS is based on the Telecom Gold System. The three areas of interest are the electronic mail facility - again, this is easy to use - a local database and a national database. The national database holds some information but as local editing is not possible and searching difficult without an agreed list of terms, we have developed a local database. We have made the front of the database look similar to the Prestel database, to maintain our image and standards. The information pages, however, take 80-column text, enabling full information, user guides, etc., to be transmitted.

The third system, **NERIS** (National Educational Resource Information Service), funded by the Department of Trade and Industry, is being used to hold information about SCET's resources. This system's pre-structured records allow resources information to be stored and sophisticated searches are possible. This is a new system which is accessed directly or through TTNS or Prestel: it shows great promise.

FUTURE PLANS

While SCET plans to maintain close links with the Information Forum, use of electronic media will be increased, possibly to include software as well as information for distribution. Paradoxically, the dissemination of information using more established libraries and resource centres will increase; all methods have a part to play. One thing is certain: SCET will all continue to recognise the importance of continuing the two-way information flow, otherwise the fruits and labours of researchers, developers and users will be of limited value.

EXPERIENCES IN IMPLEMENTING A SCHOOLS COMPUTERISED ADMINISTRATION PROGRAMME

I HAMILTON

ABSTRACT

This paper describes various issues which were considered when implementing a computerised administration system in schools on a region-wide basis. The areas covered include; management, equipment, maintenance, accommodation, implementation programme, software, training, consultation with associated bodies, user support, communications and Education Department data requirements.

BACKGROUND

One Lothian secondary school began using the Schools Computer Administration and Management Programme (SCAMP) software in May 1983 and a second school joined the project in May 1985. Both schools used Future Technology equipment which was the only system available at the time. At this stage in the development of SCAMP the cost of installing such equipment in every secondary school was prohibitive. A more basic software system, closely related to SCAMP, was developed internally to run mainly on BBC microcomputers with hard disks attached, and was trialled in seven schools.

With equipment costs falling rapidly, in May 1986 the Computer Development Executive decided that SCAMP should be installed in all fifty-one secondary schools during the financial years 1986/87 and 1987/88.

MANAGEMENT

In October 1986 an Assistant Head Teacher with experience of using computers for administration purposes was seconded to manage the planning and implementation stages of the project. In August 1987 a teacher was seconded to assist the Project Manager in this task.

EQUIPMENT

The hardware chosen comprised a computer with a 50MB hard disk and 0.5 or 1MB of memory. This equipment is capable of supporting four workstations and two printers. Schools with a roll of less than 800 pupils were given one workstation, schools with a roll greater than 800 received two. This was subsequently increased to two and three workstations respectively to cater for the identified data entry and access requirements of schools. Memory was also increased from 0.5MB to 1MB to overcome back-up problems. A 50MB streamer unit was supplied to enable a back-up of the entire contents of the hard disk to be made on a regular basis.

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Five data cartridges were provided to allow five back-up copies of the system to be held to remedy a malfunction. A fireproof safe was supplied to protect this invaluable data. A dot matrix printer capable of 300cps in draft mode and 100cps in letter quality mode was selected for printing SCAMP reports and word processing.

A desk and operator's seat are provided as standard with every workstation supplied. Recently, a printer acoustic hood has been installed in every site.

MAINTENANCE

The Lothian Project Manager is contacted initially by schools when problems occur with either the software or the hardware. When the problems cannot be dealt with at this level either SCAMP personnel or the hardware suppliers are contacted to deal with the situation. Such contacts are logged for future reference and provide an overview of the regional situation.

SCAMP deal with a problem by telephoning instructions for the Project Manager to action, or by supplying software via floppy disks or occasionally by a personal visit. The Region has a maintenance contract with the hardware supplier covering all items of equipment on an eight hour call-out basis.

ACCOMMODATION

Office accommodation requirements were assessed with regard to the ergonomic and Health and Safety environment. Minor and major adaptations were identified and the placement of schools in sub-phases of the implementation programme was affected by the scale of the adaptations and the likely speed of completion of these.

IMPLEMENTATION PROGRAMME

The forty-nine schools which required training were divided into eight sub-phases. Schools were given the basic SCAMP system initially. This comprised the Initialisation, Admissions and Class/Course Allocation sub-systems. In addition they received a copy of WordStar Professional to cater for word processing requirements. After gaining experience of these sub-systems, schools received the Registration module. This will be followed by the Exam Board module. Thereafter the order of implementation of sub-systems will be determined by their estimated benefit to the school, the impact on the school as a whole and the state of readiness for adoption.

The full range of SCAMP software was installed on the user's equipment during the initial training sessions. Users gain access to particular sub-systems after receiving training on that particular module.

Software is updated on an annual basis for enhancements and as soon as possible for fault corrections.

Each of the original four sub-systems supplied required one day's training. The first twelve schools, comprising sub-phases one and two were trained in November 1986. Similarly-sized groups were trained in February 1987, May 1987 and September 1987. Since sets of computer equipment were available at these stages of the programme, the opportunity was taken to train schools from the two previous sub-phases, on the Registration module. Future training will be more difficult to arrange on such a large scale basis since no computer equipment has been made available for training purposes and schools cannot be deprived of their equipment for any length of time due to the intensive nature of its use.

By December 1987, forty-one of the fifty-one secondary schools were using live data and seven of the remainder were estimated to be live by mid-February 1988. Full implementation should be achieved five months ahead of the original target date.

TRAINING

Schools were consulted on when they would wish to be considered for training. In the light of their requests, previous experience with computerised administration systems and the scale of adaptations required, the eight training groups were formed.

The Project Manager received training in the sub-systems to be adopted, in advance of the schools' training. Prior to the training days, a half-day meeting was organised for the senior managers who were the SCAMP co-ordinators in the schools, to give them an insight into the capabilities of the system.

The SCAMP co-ordinator and the administrative assistant or registrar from each school attended the training for the three SCAMP sub-systems. This training was conducted by SCAMP personnel. Two members of the administrative office staff attended the word processor training which was given by a Further Education lecturer. The staff who received training were required to train other members of staff on their return to school, to ensure continuity in the event of promotion, illness, retirement etc.

All training sessions to September 1987 were held at a central point in the Region with a minimum of six schools involved. October 1987 was the start date for additional training sessions on word processing on an individual basis in the client school.

Reinforcement training has been identified as a requirement in several schools. This was anticipated due to the wide range of user skills and levels of learning apparent at the initial training sessions. As might be predicted, the commitment of time and interest from senior managers in schools correlates with the speed of implementation and continuing training needs.

USER SUPPORT

The main priorities of the Project Manager are to ensure that every system remains operational and users implement the various sub-systems to the full without undue delay.

A steering group was set up, comprising four co-ordinators, four administrative assistants and the Project Manager, to provide support to all users. The group considers proposed modifications and enhancements to existing modules, provides information on procedures to be followed to achieve maximum benefits from the system, and discusses future requirements. Users are provided with information via a regular newsletter, which has recently been distributed as word processor files on a floppy disk. Users are encouraged to provide items for the agendas of steering group meetings and for the newsletter and thus share their growing expertise.

CONSULTATION WITH ASSOCIATED BODIES

To forestall any problems which might have interfered with a smooth implementation process or caused schools to modify their existing data on a large scale, the following bodies were or are still being consulted:

Computer Services
Secondary and Primary Head Teachers Executive
Head Teachers
Regional Data Protection Officer
Educational Welfare Service
Administration, Manpower and Statistics, Finance, Personnel and Property Services sections of the Education Department
Advisory Division
Procurator Fiscal
Regional Solicitor
School Health Service
Central Purchasing
Unions representing non-teaching staff
SCAMP Project Managers outwith Lothian
Lothian SCAMP Steering Group
Lothian Administrative Assistants' Association

EDUCATION DEPARTMENT DATA REQUIREMENTS

A full evaluation of the impact SCAMP is having on schools is due to begin in February 1988. Access to up-to-date accumulated data from individual schools by Education Department sections has still to be addressed. Necessary standardisation in coding of data and data input was achieved at an early stage in the project to make such access meaningful. At present there are no direct electronic links set up between individual schools and Education Headquarters for administrative purposes. Financial constraints and the uncertain level of usage and benefits which would result from the provision of direct, electronic links mitigate against such a facility being provided in the near future. However, the establishment of a system to collect and process data timeously, on a Regional basis, with minimum effort required from schools, remains a priority of the Education Department.

IN-HOUSE DATABASE

L.M.Craig*

ABSTRACT

After the closure of the UK's Microelectronics Education Programme (1980-1986), a personally funded In-House Database was set up to continue and develop the work of the Programme's Information Service. 'Creative Data' was established as a solo venture; liaising with publishers and manufacturers to create a constantly updated record of IT materials related to all subject areas of education. This working database forms the source of over 200 volumes of cross-curricular bibliographic records and reviews under the collective title of the Microelectronics Information Service for Education (M.I.S.E).

INTRODUCTION

Part of the remit of the Microelectronics Education Programme for England, Northern Ireland and Wales (1980-1986) was to co-ordinate information amongst and about those creating educational software, control devices and robotics for the classroom.

Between 1980 and 1983 there were few resources or activities relating to microelectronics in education. At this stage information was not too difficult to collate and disseminate, and it did not require computerisation. By 1984, due to the gradually increasing use of technology in schools, the need to consider setting up a National Database became apparent.

Under the guidance of the MEP National Information Officer, Librarians and keying-in staff set to work to create a Database to run on a Research Machines 480Z Network System with a 20mb Winchester hard disk. The Database Management System used was Quest (created and published by Advisory Unit, Hatfield). This was commonly used in schools, and it was the intention of the Information staff to produce discs of organised information to aid in answering the many questions asked about available resources. This Database was fully operational by 1985, under the title 'MEP Data Service'. The service distributed discs and hard copy packs of subject specific information via the network of 14 MEP Regional Information Centres in England, Wales and Northern Ireland. Complimentary copies of this information were also supplied to the Scottish Microelectronics Development Programme. This service continued until the closure of MEP in March 1986.

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DEVELOPMENT OF THE DATABASE

The MEP National Information Officer (NIO) carried out research to obtain details of materials offered by publishers and manufacturers in the UK. The skills of part-time librarians were harnessed to classify the data, and a bibliographic record of each item was entered by wordprocessing staff, who had to add this task to their existing workload. The NIO was the only full-time worker engaged in the creation of this database, and her close involvement helped her develop a sound working knowledge of its categories and contents. By 1986, when the Programme closed, the Data Service was operating through the Regional Centres but was not yet available as an on-line service. With the breaking up of the information network it seemed to many educationalists that the situation would revert to square one , and that new routes of dissemination would take a long time to develop. In the meantime, the much needed information would only be available in a haphazard and piecemeal form.

In an attempt to remedy this unsatisfactory situation, the ex-NIO used the knowledge and experience gained with MEP to create another database which would form the core of a new information service for education. Creative Data was established in April 1986, and with the help of a small Acorn BBC B computer, lists of subject specific software were written to disc. No Data Management System was used, as past experience had shown that it would not be helpful at this stage. Instead, the simple wordprocessing package, Wordwise (from Computer Concepts) assisted in creating the lists. These were extended as more publishers were contacted and their catalogue contents added. The MEP Data Service had used the skills of librarians to identify subjects by the Dewey catalogue system. The list of Dewey classifications was applied to the Data, and this resulted in a clear ordering of the software into useful, manageable areas. By September 1986, Creative Data was able to launch M.I.S.E., the recreated database, and one school magazine described it as the Phoenix rising from the Ashes . The Service offered was in the form of hard copy volumes of information which provided educationalists with bibliographic details of software, videos and books concerned with particular aspects of their teaching specialism.

The MEP Data Service had been in the process of collecting reviews from journals and magazines and requesting permission to reproduce these with the Subject Specific Packs on offer. Many of the same editors, and many new ones, agreed to give permission for release for reproduction through MISE. Each review was rekeyed and reproduced and attached to the appropriate bibliographic description of the item concerned. Educationalists were able to focus immediately on relevant materials and read a review or reviews before considering purchase, or deciding whether or not there were adequate resources to make using new technology in their subject worthwhile. Many teachers who had never used a computer could use this material to gain an understanding of the particular benefits and problems likely to be encountered with new technology in the classroom.

As MEP was closing, the UK Department of Trade and Industry was in the process of setting up N.E.R.I.S (the National Education Resources Information Service). This was to be a Database of Resources accessed via on-line Prestel, providing a Gateway to the Open University Mainframe Computer using UNIDAS software. The type of access offered had already been designed to run on ECCTIS, the information being concerned with student placings in Universities and Colleges. NERIS is attempting to coordinate information about all resources available to those concerned with education, utilising technology to speed up the process of linking customers with manufacturers and publishers.

NERIS was obviously the rightful 'home' for the MISE data, and after contacting the Director, it was agreed that work should begin as soon as possible so that the much needed information would be accessible on-line Nationally.

The MISE Database is currently being loaded on to NERIS and will therefore be available alongside other databases created by Information Providers. As the mainframe software requires wordprocessed files, these are created using Wordstar (by MicroPro) on a Research Machines Nimbus. The discs are then sent for processing on to the mainframe.

As with all sophisticated on-line systems, the software used to manipulate the data varies from mainframe to mainframe. The format for NERIS requires a bibliographic entry which includes some MISE fields, but has additional details such as 'Related Terms' which are suggestions for keywords. A team of indexers at NERIS H.Q. process the bibliographic record by adding all the search terms necessary for the user to access the record. As the data for MISE was not in a DBMS format, it was possible to provide the data by setting up 'Publisher's Files' so that each publisher/manufacturer had their own file for which they could choose to take responsibility at any time in the future.

NERIS had, up to the MISE contribution, only been able to load contributions from sources which had selected items from a range of publishers to include in 'Subject files' such as 'Special Needs', 'Business Studies' or 'Further Education'. This resulted in a useful selection but an inadequate system for checking that the records were correct and up to date. Unlike books, software is reversioned, rewritten and given new titles, deleted after a short life (compared to books) or combined into larger packages (many cassette programs were combined with others when disc drives were introduced). This highly volatile information required particular care if the NERIS database was to be a credible and reliable source. The 'Publisher's File' goes a long way towards retaining accuracy.

Each Publisher/Manufacturer receives a printout of their file entry before it is uploaded, as part of the NERIS service provided by MISE. For many, this is their first sight of entries as few have accessed NERIS (to date). Contact with the publishers is also proving to be an 'awareness programme', encouraging them to feel their work is at last being recognised. The associated reviews written by a variety of sources are also printed out. This leads to some publisher's being able to point out that many critical reviews are now not relevant, as earlier versions of the product have been modified. This 'Publisher's File' is then amended and reviewers informed that their earlier remarks have been noted and helpful in the refinement of the product.

The MISE database is constantly being added to and all updates to it will also be added to NERIS. It might be thought expedient to utilise more people to key-in records, just as many on-line databases employ large numbers of staff. It is obviously wise to do so when the data is non-volatile. However, if the data is volatile, and large amounts need to be keyed in over a short period, it is perhaps worth considering allocating small, manageable chunks of information to individuals, who will become familiar with it and so utilise their personal experience of the data to ensure more accuracy.

In the case of microelectronics information, not only are the contents of the Publisher's Files volatile, but the existence of Publishers themselves is also subject to change! When these changes take place, the database must be amended to avoid users persuing products no longer available in their previous form.

The important stage we are approaching now is that of assessing the UK microelectronics related product output to date and deciding which developments move us forward in providing educational environments to enhance our current non-technological understanding of learning. Educationalists need on-line information systems to help them assess the vast range of good and bad items designed for different target groups and types of equipment.

It is hoped that the MISE database contributes to a growing awareness of the UK effort to produce material which will lead to classroom learning experiences that exploit new technology in ways that are stimulating, responsible, practical and exciting.

USING DATABASES IN EDUCATION - experiences from Sweden

Monica Andersson*

MOTIVES

Education has the goal to bring knowledge to human beings in a society. Knowledge about what? - Knowledge within a profession or how to behave in the society for example.- If the society is, or is going to be, technically advanced it is of great importance that education can use the same technology. If databases are used to handle information in the society pupils should be prepared for this in school.

Preparation for the future profession of the student.

The student should know about those databases that can be of value in his profession. Often it is just a few bases that will be of interest. Perhaps a bibliographic database that can give references to new publications in the field of his profession or a base that gives the adresses to possible future clients. The student should know where to look for interesting databases and how to use the most common ones.

Aquaintance with databases in general.

Databases represent a model of the real fact, the source. A selection has been made and facts have been organized in a special way, perhaps different from the source. Facts can have been changed or omitted to suit the structure of the database. Students should be aware of all this to get a critical attitude towards the information presented in the base.
When a new technique like databases is used, it's important that it is consistent with the rules that define the rest of society. With databases and datacommunications, information can easily be distibuted and multiplied. It is difficult to supervise. Nevertheless human integrity and the rules of secrecy must be protected. These things must be dealt with in school. The student also must learn that information represents a value, and that he, under certain circumstances, violates the law when misusing it.

Databases as a support in education.

Much information is produced every day all over the world. The problem today is how to get hold of and handle the information. The database as an instrument to organize and distribute data is also a good help for students in their studies. To be able to get the latest news about an issue studied in school, by means of articles in different papers and with the help of a fulltext database, makes the studies realistic. The student will be able to deal with real, accurate facts instead of historical facts in a text-book. If the database is well done it can also be the easiest way to get the information. Many bases today are not that easy to use but the systems are improving. One gateway to many different databases with a common user-interface helps to make the usage easier. Then the student will get a good help in her independent studies. It will be important for democracy that the citizen can find out by herself the facts about a subject under discussion in the future information society. Therefore much training in school must be in the form of research and investigation and the database can be a facility to make this possible.

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DIFFERENT TYPES OF DATABASES

Bibliographic databases.
When the student is working independently with a specific topic, a bibliographic database can give the references to information about that topic. After having printed out those references that are supposed to be of interest for the study, the student has to get the source material in some way. If the base has referred to an article in a book, a magazine or a newspaper the source can be found in a library, perhaps inside the school. If the school is not in possession of the article, an arrangement must be made to bring the information to the student. Perhaps the library and the school can come to an agreement to send the article. Then the best and quickest way to do this is with telefax. The telefax-equipment is not too expensive, the transmission is cheap and the student gets the article with not too much delay. Under this session the student also has to decide about which sources to exploit and which ones that are of less importance, because the database often gives more references than the student will have time to penetrate.

In Sweden there are some bibliographic databases of specific interest for educational use. In Artikel-Sök at Bibliotekstjänst you get references to 50 Swedish newspapers and 450 Swedish journals. In Bodil and VA-Nytt at Byggdok you get references to Scandinavian publications about civil engineering, social environments and so on. Aramis gives references to Swedish and international research and other literature on labour and social environments. In Nyttfo at DataArkiv you get references to all ongoing research and development-projects at the universities in Sweden. Then there are of course all the international bibliographic databases. Some of them are possible to reach through a gateway at DataArkiv. Then you can use the same interface as with the Swedish bases.

It would be a pity, though, if the educational system tries to select some bases that will be accessible for the students instead of letting the student's need for information be governing in every specific situation. This is necessary if we want to acheive research in school as a part of education.

Statistical and other databases with structured data.
In Sweden there are two bases, TSDB and RSDB at The Statistical Central Office (SCB), where you get statistics about industry, labour market, prices etc. In Rättsbanken at Dafa AB you get information about legislation. Etc.

The information retrieved can be used in different disciplines like social science and mathematics.

These kinds of databases often require some preliminary knowledge about what is studied. When using a statistical database the student must know the statistical terms. The student also must be able to rearrange the result with the help of a software-tool, for example a statistical package.

Fulltext databases.
These databases are for the most easy to use. The student gets all the information at once on the screen. Then he can focus on parts of the text and print it on paper. A printed text is easy to read and gives a good overwiev. A word-processor is also a good help to handle all the data that are extracted from a fulltext database.

In TTNyhetsbanken at DataArkiv you get all releases from the news-agencies. In Tidningsdatabasen at Affärsdata you get the fulltext of several Swedish economic papers. You can also use the gateway at DataArkiv to get World Reporter. Etc.

SUPPORT WHEN STARTING TO USE DATABASES

Seminars and conferences.

When new technologies like databases are used in the educational system it affects the whole environment of education. The way of teaching and learning will be different. Therefore it is important for teachers to get an opportunity to exchange experiences. Seminars have been arranged in Sweden where teachers could explore the benefits of different databases and discuss the usage of databases in education and several arrangements are planned for the near future.

Sökekonferens.

The Scandinavian countries are cooperating in this area and in February 1988 a "Sökekonferens" (conference on information retrieval) is arranged in Norway. Teachers and librarians from each Nordic country: Denmark, Finland, Iceland, Norway and Sweden, will meet during three days. They will together, and with their different views, try to find out what promises the use of databases in education can give. The seminar is partly financed by NORDINFO.

SkolKOM.

An electronic conference-system, skolKOM, for teachers and teacher-trainees in Sweden is running as an experiment during 8 months in 1988. In skolKOM every issue of educational development can be discussed and specially the use of new technology. Both teachers familiar with the use of computers and novices will attend skolKOM. Hopefully it will put datacommunication and external networking at a level, where teachers will not hesitate to use it even to get to external databases.

Databas88.

In January 1988 a large Nordic conference on databases is taking place in Sweden. A special seminar for the school system is arranged within the conference and school-politicians and decision-makers have been invited to this seminar. It will deal with the question how information can be used to support the administration and the commercial and industrial life in a region and how education can play an active role in this development.

Publications.

Two publicatons about using databases in education, one Swedish and one on a Nordic basis, will be published during 1988. The Swedish one is about the motives for using databases in education, databases and the curriculum, databases and the legislation, some practical advice about databases etc. This publication is financed by The Delegation of Scientific and Technical Information and The DataProgrammeGroup of The Swedish Ministry of Education.

The Nordic publication is about schools using databases in different ways. Some schools use external public databases, some use local bases, suitable for their special needs, and others use both external and local. This publication is financed by The Nordic Council.

AN INFOCENTER IN THE MIDDLE OF THE SCHOOL

Let us hope that the future will bring us an infocenter as the heart of the school. A center where the student can get information from films, books, journals, newspapers, records, pictures, computer-software, databases etc to help him in his research work. This center will be administrated by the librarian, the teacher will be responsible for the educational use and the student will be the end user.

COMPUTER COMMUNICATIONS AS AN INTERACTIVE INSTRUCTIONAL TOOL

Richard Riedl

ABSTRACT

Faculty and students at the University of Alaska Fairbanks have access to the University of Alaska Computer Network which provides service throughout the state. Included on the system is an electronic mail system and other utilities that make it possible for users to readily communicate with each other. It is on this system that experiments in multidimensional communications are taking place. The purpose of these efforts is to develop the means of providing significant teacher-to-student, student-to-student, and teacher or student-to-class communications for students who are unable, because of location or time constraints, to attend traditional class meetings.

Because the computer communication medium is different from traditional oral or written communications, it is necessary to learn the limitations and advantages of computer communications as an interactive instructional tool. Experiences in offering classwork through this medium suggest some approaches that facilitate the use of such a system.

COMPUTER COMMUNICATIONS AS AN INTERACTIVE INSTRUCTIONAL TOOL

Several faculty members in the University of Alaska and in the College of Human and Rural Development at the University of Alaska Fairbanks have used the messaging capabilities of the University of Alaska Computer Network as part of their course delivery efforts for students in remote locations. These efforts have ranged from using the computer network as the sole mode of communication, combining its use with audioconferencing, to combinations of class meetings and network use. In many of these efforts, the focus was on utilizing the computer messaging system as a means of discussion on class topics.

One of the most common modes for using the system has been to establish a class userid which served a class mailbox. This class mailbox is made public--anybody can read its contents. Each student is given his/her own userid which is private. Students can get on the computer system on their private userid and access (read and send messages to) the public class mailbox from it. Thus, the class discussion occurs on the public mailbox with the added option of private communication between students and between individual students and the teacher being available through the personal userids.

What follows is a summary of what those using this system have learned about computer communications as an interactive instructional tool.

1. There are significant indications that computer communication systems can sustain quality interactions (ref 2,3,5). Duranti (ref 2) observed that communications typed in to a computer messaging system

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are often stilted and do not exploit all of the possibilities of the system. To become effective users of the computer communications system the students and teacher must find a middle road between free flowing oral discussion and "trading papers."

2. Discussion tends to become multi-leveled, with several threads of discussion going on at the same time. Unlike typical classroom or audioconference discussions, in which only one topic at a time can be pursued, there are several topics and variations of topics on the floor at any given time in the computer communications discussion (ref 5,6,9). The topics or threads are also not necessarily sequenced by time since students are dropping in and out of the discussion at a wide variety of times. The result is a rich "soup" that can be disconcerting to new users whose experience is limited to the more controlled and sequenced classroom environment. Course outlines need to be structured to take advantage of these multiple threads by avoiding traditional sequential course organization (ref 5).

3. Quinn, et al (ref 5) suggest that computer communications discussions should be "organized by using message headers." The purpose of headers is to facilitate the ability to follow a thread of the discussion by accessing messages through the headers. This is probably necessary for large classes, but in small classes (5-15 students) the students appear to be able to follow the multiple strands reasonably well without message headers.

4. As a multi-leveled, non-sequential event, the discussion makes different demands on the instructor or discussion leader. As mentioned above, planning becomes more complex than simply establishing a sequence of topics. Also, the participation of the instructor becomes very different. Because there is no physical proximity nor any assumption of time sequence, the instructor is more free to pick and choose when to add to or attempt to redirect the focus of the discussion. There is less pressure to respond to every comment students make than in the typical face-to-face situation. The instructor can read what has been contributed to the discussion, print it out and re-read it, put it aside, re-read it later, and then make a decision about whether to put anything into the discussion or not. In some cases the time to think about the ongoing discussion is necessary because it has become so complex. It is more difficult for the instructor to exert influence over the course of the discussion because of the multiple threads and the lack of direct control that exists in the classroom. For the purposes of decision-making and evaluation there is the advantage that the discussion has been recorded on the computer and can be reviewed in its entirety.

5. With a public mailbox serving as the open discussion area for the class and a private mailbox for each individual involved in the discussion, there is the opportunity to switch easily from the public to the private aspects of discussion. This gives the instructor, when deciding to add interjections to the discussion, the option of making public comments on what a student has added or to speak directly to the student via the private mailbox. The students have the same option, whether directing their comments to another student or to the instructor. If used effectively, this can be a very positive enhancement of the discussion.

With these aspects, potentials, and problems of using computer communication as a discussion medium, how then does one begin a class discussion among widely dispersed students?

First, there must be a strong enough support system to introduce those who have never used computer communications to its use and to be a continued presence when problems arise. This, and access to the system, prove to be the largest barriers to the use of computer communications in sparsely populated areas. In high density, high technology populations one can count on a certain number of people to be knowledgeable in the use of computer communications. Use of the medium in instruction in highly populated areas draws upon such people and can become self supporting relatively quickly. This is not true in low population density, low computer technology areas. It becomes important for the agency offering the instructional opportunity to facilitate the access and support needed for the use of the medium. Without such effort, the use of computer communication for instruction will become an exercise in frustration for the students and the instructor.

Once adequate access to and support for the use of the computer communications system is in place, the instruction can begin. The instructor needs to provide several things if there is going to be a good discussion.

1. The written materials for the course need to be clear and to give the students many things to think about. If there is a text, it should not be too heavy with answers, but should raise questions about the subjects being covered.

2. The course outline should be planned to be additive in nature. That is, instead of containing a set of discrete topics, it should have topics that interrelate to each other and pick up on previous topics. No topic should ever be considered finished.

3. Early course requirements should be explicit in the kinds of participation requested. A first requirement should probably be that all the students (and the instructor) introduce themselves via the computer during the very beginning of the class. Early requests for contributions to the discussion should be direct and ask for simple statements on a familiar aspect of the topic. The students must be given a chance to get used to the system, feel free to make mistakes in its use, and learn its possibilities.

4. If possible, encourage students to print out the messages they want to read and to write notes on them before responding. Most students are tempted to read (on the monitor screen) and immediately respond to the messages they find on the system. Their responses tend to become more thoughtful and contribute more to the discussion if they will take the time to read the hard copy and take notes. Sometimes, however, it is better for the purposes of discussion if the student reacts immediately to what has been written. Too much time between reaction and response can lead to stilted and paper-like additions to the discussion.

5. The instructor must model a variety of forms of interaction on the system. There are a range of messages that can be sent; from chatty, informal bits to formal, researched responses and a great deal in between. The instructor must be prepared to show the students this range so that they can use and explore it as well.

Computer communications can be a very effective mode of interaction for widely dispersed students. Beyond the skill of the instructor in eliciting student participation, perhaps the most crucial aspect in its use is providing easy and open access to the system to be used and a great deal of readily available support to the new user. If those can be provided, there is a great opportunity for students, regardless of location or schedule, to participate in a rewarding educational experience that can match anything provided in a classroom.

REFERENCES

1. C Barnhardt, "Distance Delivery of University of Alaska Courses Via Computer," Correspondence Study Program, University of Alaska, Unpublished (April 1987).

2. A Duranti, "Framing Discourse in a New Medium: Openings in Electronic Mail," The Quarterly Newsletter of the Laboratory of Comparative Human Cognition (April 1986).

3. R S Hiltz and M Turoff, The Network Nation: Human Communication via Computer (Addison-Wesley Publishing Company, Inc., Reading, MA, 1978).

4. K Janda, "Computer Augmented Teaching in Large Lecture Courses: The Case of American Government," Academic Computing 2(2), pp.34-35, 42-43 (October 1987).

5. C N Quinn, H Mehan, J A Levin and S D Black, "Real Education in Non-Real Time: The Use of Electronic Message Systems for Instruction," Instructional Science (November 1983).

6. R Riedl, "The Computer Mediated Class," The Capstone Journal of Education, University of Alabama (In Press).

7. R Riedl, "The Classroom That Isn't...Computer Mediated Instruction," University of Alaska Magazine (March 1985).

8. R Scollon, Computer Conferencing: A Medium for Appropriate Time, Center for Cross Cultural Studies, University of Alaska, Fairbanks (1982).

9. S Scollon and R Scollon, Computer Conferencing in Instruction, Center for Cross Cultural Studies, University of Alaska, Fairbanks (1981).

10. S Scollon and R Scollon, Face in Interethnic Telecommunications at the University of Alaska: Computer Conferencing and Non-Focused Interaction, Paper presented at the Conference on Native American Interaction Patterns, University of Alaska (1982).

RADIOTEL : A NETWORK USING DATA TRANSMISSION ON A SIDE BAND OF A COMMERCIAL FM STEREO RADIO CHANNEL

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INTRODUCTION

Radiotel is a digital network using both telephone and radio channels. It was developed within the Physics Department of the University of Parma and tested with the cooperation of the Emilia-Romagna Regional Department of RAI, the Italian National Broadcasting network, as one of the activities promoted by the Regional Administration in cooperation with the IRRSAE (Istituto Regionale di Ricerca e Sperimentazione sulle Attività Educative) and the LIPI (Laboratorio Interprovinciale di Informatica delle provincie di Parma e Piacenza).

In 1985, a series of 12 lectures was broadcasted, using the original version of Radiotel. The data sent during the transmission were received and processed by computers in 30 sites (schools and professional centers).

These lectures were on introductory computer programming using the italian version of Pattis's "Karel the Robot", developed by the ITD (Istituto per le Tecnologie Didattiche del CNR) of Genova.

In February 1988 a new series of 12 lectures will be broadcasted. This series is based on the Logo language and will be aimed at teachers of elementary and middle school. Logo was chosen for its educational value in approaching programming and computers.

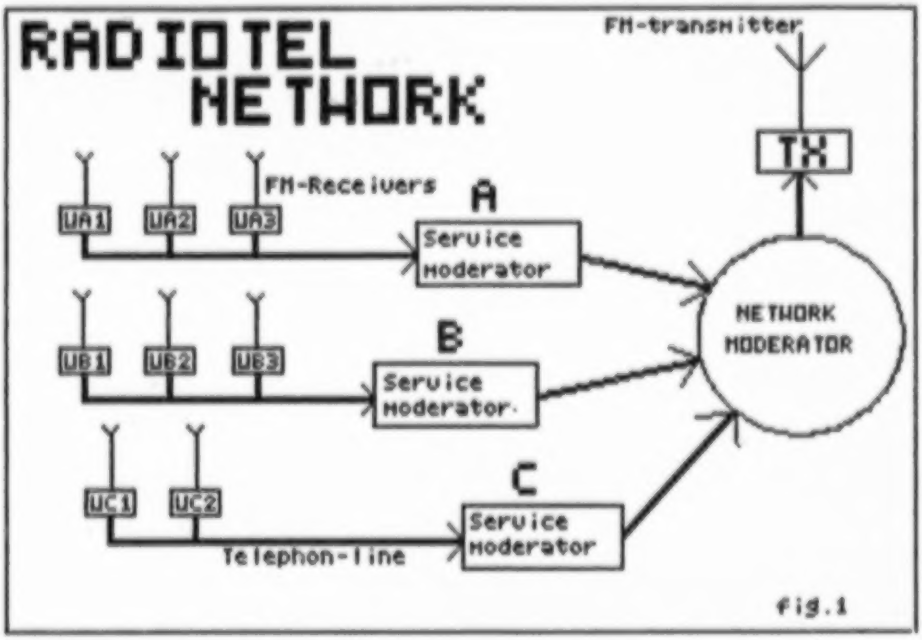

fig.1

The interface (hardware and software) between the radio and the computer has been made so that the communication is independent of the make of receiving computer, operating

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system and language in use. The files broadcasted by FM stations are received using commercial radio sets together with the normal stereophonic transmission (fig.1).
This is possible because this transmission does not use the entire 75 kHz band width, standard for FM radio broadcasting, and there is a side band (between 53 and 75 kHz) in which data can be introduced without interfering with normal transmission. In order to minimize the possibility of error, the baud rate should not excede 2400 bit/sec.
Both text and binary files can be received and processed by the user. It is possible to send the files selectively to a particular site or type of computer. Some of these files can be catalogs of other files to be sent via radio.
Files not currently broadcasted can be received by making a telephon request to the computer connected to the radio station, which keeps these files and handles their transmission via radio.
The user has a program on his computer which helps him to formulate the request and send it to the remote computer by managing the telephone call (fig.1). In this way, the telephone line and the remote computer resources are used only for the time required to send a short file, thus minimizing both telephone bills and the dimension of the system.

TRANSMISSION AND DETECTION INTERFACE

The communication protocol, based on the serial asyncronous RS-232 standard, makes use of a frequency modulation technique to send data through the radio-channel, together with software to compose the files to be sent in order to introduce information which will be used by the intelligent demodulation board on the receiving side.

MODULATOR

The data signals from the RS-232 output control a VCO which generates sinusoidal waves at the two selected frequencies (70 and 64 kHz for the 1 and 0 logical states, respectively). These are summed to the audio signal coming from the stereo encoder, and sent to an FM transmitter. The selection of the 70 and 64 kHz frequencies for encoding of the digital signals was determined by the necessity to stay as far away as possible from the frequency band generated for the audio signals by the stereo encoder (0–15 kHz for Right + Left and 25–53 kHz for the Right – Left signals), but still to remain within the allowed bandwidth (±75 kHz) of a commercial FM broadcasting station.

TRANSMISSION SOFTWARE

The transmission program, resident into the main computer of the broadcasting station, has been written in Pascal. Its output is a binary file which is sent through the transmitter.
The transmission protocol has been designed to broadcast various type of information such as texts, source and machine coded programs, data and graphics. The receptors of the information are home- and personal-computers different in both hardware and available software. In short we are dealing simultaneously with different operating systems and programming languages. In a single broadcasting session it may be necessary to send files which potentially carry different information for different users; for these reasons each file must be organized in blocks, each of which is preceded by a header which contains

the following fields:

1- a file and a block number;
2- a code identifying the file type (text, program, data, graphics, etc.);
3- an identification of the type of receiving computer;
4- a code to select a particular user or a group;
5- optional codes for automatic processing of the incoming file (print an instruction file, do graphics, compile a source program, execute it, etc.).

Moreover, since files may be sent in ASCII or binary, the protocol should guarantee the transmission transparency.

The final aim of the protocol is to provide the possibility to detect and correct transmission errors. For this purpose to each block a CRC (cyclic redundancy code) is added, allowing error detection by the receiving system. The correction is achieved through multiple transmission of the blocks.

RECEIVING INTERFACE

The general block diagram of the detection system is shown in Fig. 2. As can be seen, the first part is essentially a normal FM radio from which the low frequency composite signal, just before the stereo decoding circuit, is taken out and amplified. The signal is then filtered through a high pass RC filter with a cut-off frequency at 53 kHz and sent, in parallel, to two active filters, tuned at 70 and 64 kHz respectively, each with 3 kHz bandwidth. Their outputs after a full wave active rectifier are smoothed by an RC integration circuit with 0.1 msec time constant. A comparator in differential mode, with output levels to match RS-232 standard, recostructs the original to be sent to the Received Data Control board.

To avoid writing a different program for each type of computer, many parts of it in machine code for speed's sake, and also to provide the users with an easy-to-handle program, we decided to design a microprocessor based board to manage all operations involved in the protocol and therefore with the reconstruction and selection of the correct files transmitted. Communication between the user's computer and the microprocessor board is standard serial and handled trough a very simple software interface, thus there will be only one program inside the computer to present the data correctly when requested.

The receiving board consists in a demodulator and a Motorola 6809 microprocessor system which handles the receiving program. A Ram large enough to handle files of 30 Kbytes is provided. An ACIA handles the incoming data while another ACIA provides communication to the user's computer.

The reception program, written in PASCAL and ASSEMBLER, rebuilds the files from the blocks received and provides the users with all the facilities required to handle these files, such as printing, saving, displaying and executing.

The computer can give the following commands to the board:

select the files to be received
start reception
show reception status
stop reception
show transmission error statistic
transfer list of received files and the respective references
transfer a specific file

In this configuration a program in the language more suitable for a particular application may handle the files and present the data to the user.

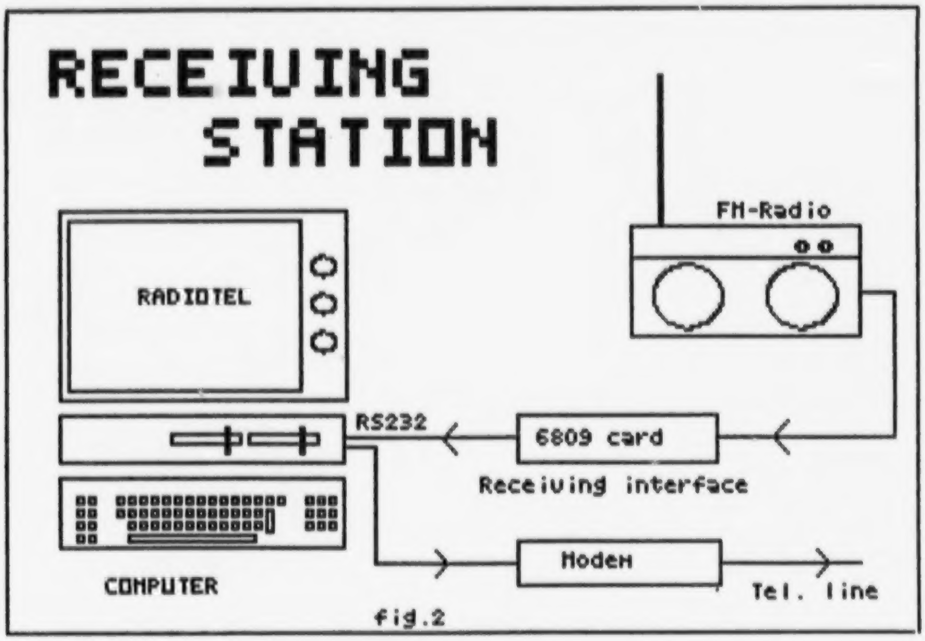

fig.2

CONCLUSIONS

The system proposed has the capacity for considerable development in the field of " long-distance " education, professional training and updating of personnel. Aside from the "Universitá Popolare" (People's University) there have been extremely few educational efforts in Italy aimed at persons who are not involved with or part of the formal scholastic structure.

When combined with lectures Radiotel can be a powerfull tool : oral information and images can complement one another, processable software can be brodcasted, and finally, the system provides for telephon interaction and feedback.

As far as professional training is concerned, the authors would like to point out that there is, most of the time, considerable difficulty in finding enough highly-qualified personnel to teach in particularly specialized sectors of the emerging technological fields. The use of "long-distance" teaching maximizes the capacity of high level experts to produce educational packages that are reproducible and can be utilized in differen contexts. This is the case when there is a requirement for high professional qualifications with a particularly low territorial diffusion. In this case, residential courses became too expensdive, while travelling courses are inefficient method for the update. Radiotel could serve to overcome some of these difficulties. With Radiotel, course material in which oral "support" (recorded lectures, video cassettes, etc.) can be furnished in another fashion, while tests, exercises, examples, basic data consultation, tutor's answers can be furnished via radio and saved on a disck for later use.

THE IBM HUMANITIES PROJECT AT OXFORD UNIVERSITY

Jonathan Darby*

ABSTRACT

IBM have sponsored a significant project at Oxford University's Computing Teaching Centre intended to promote the use of computers when teaching politics, philosophy and economics to "PPE" undergraduates.

In philosophy a program has been written which teaches the tableau method of analysing arguments formalised in first-order logic. Particular emphasis has been placed on the user interface with the intention that use of the program should be as intuitive as possible.

In economics we are developing software to teach through interactive models a range of topics relevant to undergraduate teaching.

Insights gained from the evaluation of the project are discussed.

INTRODUCTION

As one of the oldest universities in the world, Oxford has accumulated a wealth of traditions and practices. Great store is placed on teaching through individual and very small group tutorials. The University also has some unique degree subject combinations. Politics, Philosophy and Economics (PPE) is one such combination which was first taught in 1921. With the strong emphasis on the traditional tutorial teaching method (even lectures are considered optional) few PPE students have had any opportunity or need to use computers.

For several years now two Oxford tutors (John Wright, an economist and Dr Bill Newton-Smith, a philosopher) have been trying in a small way to remedy this state of affairs. John Wright had started work on a general purpose economic modelling package, designed specifically for undergraduate teaching, back in 1983, while Bill Newton-Smith has written two logic teaching programs to accompany his book "Logic: an Introductory Course" (ref 1). This pioneering work was used as the basis for the project. It was decided to base the project in the Computing Teaching Centre since its expertise in using computers in teaching was seen as a vital ingredient for the success of the project. The IBM Trust was approached for backing and they agreed to meet a substantial proportion of the costs of the project. We are most appreciative of their generous support.

CHOICE OF EQUIPMENT

Decisions had to be made about the equipment to be used on the project in the Spring of 1985. We realised that high quality graphics were going to

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be essential and that fairly powerful computers would be needed to cope with the computational demands of the economics side of the project. We therefor came to the conclusion that we should require PC ATs each with a maths co-processor and Enhanced Graphics Adaptor (EGA) and display. Both ATs and EGAs were fairly new and expensive at the time but we predicted that both would be relatively cheap and commonplace by the time the software had been developed. This has indeed been proved correct with prices for AT compatible computers starting at about £800, and with EGA colour graphics adding another £200 - £300 to this.

We were also clear that we required our computers to be networked, as maintaining the integrity of the system when all software has to be retained on 20 separate computers would add considerably to the support effort required. Other obvious advantages of a network are the ability to share printers and the potential for central record keeping of things like student achievements. We therefor specified IBM's PC Network (Token Ring had not yet been announced). This has proved reliable and acceptably fast. The equipment configuration is summarised in Figure 1.

Figure 1 - Equipment Configuration

17 Network Stations:	IBM PC AT with 80287 maths co-processor 640K main memory & 1024K of virtual disk 1.2Mbyte floppy disc drive EGA displays (350 x 640 & 16 colours) IBM PC Network interface Microsoft compatible serial mouse
1 Programmer Station:	as Network Station plus 20Mbyte hard disc IBM Quietwriter printer IBM Colour Inkjet printer
2 Network Servers:	as Network Station but with 2048K virtual disk 20Mbyte & 80Mbyte hard discs IBM Proprinter

THE STUDENT ENVIRONMENT

One of the problems faced by new users of computers is the general unfriendliness of the operating system that the student has to negotiate on the way to using any program. This is particularly true with DOS which in its raw form provides no help if the student gets stuck and very little feed-back if a command is entered incorrectly. Another problem faced by users of teaching software is the great variety of "driving mechanisms" employed by the software and the wide variation of standards in areas like the provision of on-screen help. Our approach has been to search for a common standard to cover both the user interface presented by our teaching software and a "shell" to protect users from DOS. Our term for this is the "student environment".

Before embarking on any software development we conducted an informal review of user interfaces and of student views of them. The conclusions of our review form the basis of our student environment guidelines summarised in Figure 2.

Figure 2 - Student Environment Guidelines

Help	* help should always be available * how to get help should be shown on screen at all times * help should be context sensitive * the help message should not replace or cover the thing it is providing the help on * help texts should not be written by the developer alone
Screen	* use colour methodically to indicate context * exploit the intuitive feel of "point and select" with a mouse * windows should be used for temporary messages * pull down menus help avoid a cluttered screen and are easy to use
Keys	* minimise number of keys used but don't make them multi-functional * the effect of pressing wrong keys should be anticipated and minimised * users should never need to memorise key actions
General	* the knowledge needed to run a program should be minimised * it should be possible to leave a program at any point and information on how to do so should be on screen * something should always happen after a command is issued

When developing software from scratch you have complete control over its user interface, but when you take on board someone else's software you generally have to accept the user interface supplied. An idea that we hope to explore in the future is the development of a technique for running software under the control of a "shell" program. This would enable modification of the controls of the program to fit our local standard. Extra help and guidance could be provided for software not originally designed for teaching purposes.

LOGIC

Although the University offers lectures in formal logic, it is mainly taught through individual tutorials. Most tutors use the book "Logic" by Wilfred Hodges (ref 2) as their set text and require students to use the "tableau" method described in it to solve set problems. This method is also used by Jeffrey (ref 3) and by Smullyan (ref 4). The marking of students' proofs is a time consuming and tedious task which few tutors enjoy. Our program "Tableau"[*] aims to relieve tutors of this drudgery while at the same time providing students with immediate feedback, and help as necessary, while developing their proofs.

Tableau was the first program to be developed by the project and we decided to take full advantage of the capabilities of the hardware we had at our disposal. It makes full use of mice and EGA graphics. This could have resulted in limited portability had we not made extensive use of an object oriented graphics package MetaWINDOW. This approach not only speeded software development considerably but it has also meant that adaptation to other graphics standards and other mice has been simple.

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[*] Tableau was written by Duncan Watt (now at Leeds University) assisted by Michael Potter.

ECONOMICS

Our aim in economics is to create a complete course that students can use like a book, but which lets them explore various economic models interactively. At frequent intervals students are encouraged to observe graphically the effects of altering key parameters, and in some cases the models themselves. Topics already completed include macro economics and general equilibrium theory. A topic generator is also planned in order to enable non-programmers to create their own teaching materials.

POLITICS

In Politics we have developed games using software which simulates the "Prisoner's Dilemma". We plan to develop a networked version of the software which will enable the simulation of much more complex (and realistic) situations.

EVALUATION

There is no compulsion for students to make use of our software so student attendances give us an indication of its perceived usefulness. During the first term of use around 70% of all first year logic students used it at least once. The average attendance was three visits totalling 6 hours. It was noticeable that no students at all came from certain colleges. We are in the process of interviewing tutors in an effort to find out in what way tutor attitudes are influencing their students' attitudes. Student comments on Tableau have been enthusiastic. We are in the middle of analysing a questionnaire on Tableau that has been sent to all PPE students.

REFERENCES

1. W H Newton-Smith, Logic: An Introductory Course (Routledge & Kegan Paul, London, 1985)

2. W Hodges, Logic (Penguin, London, 1977)

3. R C Jeffrey, Formal Logic: Its Scope and Limits (McGraw-Hill, NY, 1987)

4. R M Smullyan, First-Order Logic (Springer-Verlag, NY, 1968)

EDUCATIONAL TECHNOLOGY IN CALIFORNIA SCHOOLS STATE INITIATIVES AND LEADERSHIP: 1982 - 1988

Martin L. Harris*

ABSTRACT

This paper traces the role of state initiatives and leadership in supporting and promoting the use of educational technology in California's public schools from 1982 through 1988.

A brief overview of California's governance structure for education is presented to provide the context for later discussion.

Three major initiatives related to educational technology have been implemented in California: the creation of Teacher Education and Technology Centers (TECCs), the Educational Technology Local Assistance Program (AB 803), and the passage of AB 1681 (Statutes of 1986) required that teachers receiving a clear credential after July 1, 1988 demonstrate competence in general and specific applications of computers to education.

Finally, the future of these initiatives is discussed in light of budget cuts for 1987/88 and an increasingly tight state budget.

BACKGROUND

The vast cultural, geographic, and ethnic diversity of California is matched only by the political and administrative structure governing its education system. More than 4.4 million students are served by 185,000 teachers in nearly 8000 schools. The system is governed by 1039 Local Education Authorities (LEAs), each with its own elected Board of Trustees. These LEAs serve from 35 to 600,000+ students, with nearly 300 of them serving less than 500 students each. Each of the 58 counties has an Office of Education providing a myriad of services to local districts and governed by its elected Board of Trustees and led, in most cases, by an elected Superintendent of Schools.

State level leadership for curriculum, administration and accountability is provided by the California State Department of Education, headed by the Superintendent of Public Instruction, elected in a state-wide election process.

The California Legislature comprises an Assembly and a Senate, each of which can originate legislation affecting education. The Administration Branch of state government is headed by an elected Governor, who has line-item veto power over legislation passed by the Assembly and Senate.

Last, but not least, is the California State Board of Education, an appointed body that sets educational policy for the state's public schools and oversees the operations of the State Department of Education.

It is within the context of this labyrinth of frequently competing political and administrative organizations, each advocating its own version of "local control" of the educational process, that policies and programs for the use of educational technology have been shaped.

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TEACHER EDUCATION AND COMPUTER CENTERS

As part of a comprehensive reform effort initiated by Senate Bill 813 (Statutes of 1983) 15 regional Teacher Education and Computer Centers (TECCs) were established, each housed in a county office of education, but operated under guidelines provided by the State Department of Education. Additionally, each TECC had its own Policy Board to guide its operations, a majority of whose members were classroom teachers.

Overall funding for TECCs was approximately $6,000,000/year in 1982/83 and 1983/84 and approximately $10,500,000/year in 1984/85 through 1986/87.

While the mission of the TECCs evolved as the educational reform effort took hold, they were originally charged with training in the application of computer technology in the classroom, increasing teacher proficiency in the areas of math and science, and training teachers in instructional methodology. Thus the early focus of TEC Center training for teachers was on computer awareness and "computer literacy." Classes were typically one to three days in duration and provided a broad overview of computer use. In 1984/85, the last year for which data are available, TECCs state-wide provided some 14,000 hours of computer-related training that reached approximately 38,000 individuals.

In addition to providing specific training, most TECCs also provided consulting services to LEAs and individual schools on the application of computer technology in the classroom. With the advent of AB 803 (described below) TECCs took on a larger role in assisting districts with planning and grant writing to obtain funds for educational technology. TEC Centers also provided preview facilities for educational software. Through a state-wide clearing house publishers provided preview copies of software which were distributed to TECCs for review and evaluation.

In the spring of 1987 all TECCs wrote operational plans for 1987/88 that focussed heavily on training in content, methodology and use of educational technology in specific curriculum areas. These plans represented a considerable growth in understanding how technology can impact the teaching of specific subjects and built upon products produced through AB 803 funding.

EDUCATIONAL TECHNOLOGY LOCAL ASSISTANCE PROGRAM (AB 803)

In 1983 the Educational Technology Local Assistance Program was enacted by the legislature. This program expanded provisions of legislation passed in 1982 to include computer technology and by authorizing a number of grant programs designed to support other state-wide curriculum reform efforts, including grants to district and county offices of education for computer education or educational technology programs; grants to Teacher Education and Computer Centers (TECCs) for assistance in implementing technology programs; grants for instructional television; and grants for research studies. It also required that school districts develop comprehensive plans for the use of educational technology in the regular curriculum as a prerequisite to receiving state funds for technology-related purposes.

In addition to the grant programs a number of developmental activities related to improving the use of technology in instruction were authorized: production of software standards or guidelines; development of software; development of a long-range strategy for improving preparation of students for employment in technological fields; and working with industry and business to inform them of the needs of schools for technological equipment, training and other technical assistance. Finally, the legislation authorizes the Superintendent of Public Instruction to acquire and distribute instructional programming (including computer software and video programming) for state-wide use through purchase, lease, or other agreement.

An Educational Technology Committee, comprising thirteen members appointed by a variety of political entities, is charged with advising the State Superintendent and the State Board of Education on the allocation of funds. Day-to-day responsibility for program administration lies in the Office of Educational Technology at the State Department of Education.

Five major initiatives have provided the framework for AB 803 activities: District and County Grants, Regional Support Services, Curriculum Materials Development and Acquisition, Staff Development, and State Leadership. Table 1 shows the expenditure of funds on these initiatives.

	Fiscal Year				
	1983/ 1984	1984/ 1985	1985/ 1986	1986/ 1987	1987/ 1988
District & County Matching Grants	1.1	8.9	17.0	17.9	7.6
Technical Assistance	.0	2.5	2.3	4.2	1.8
Curriculum Development/ Program Acquisition	.1	1.8	3.2	2.1	.8
Staff Development	.0	.0	2.9	1.2	2.0
Hardware Acquisition	.0	1.8	.0	.0	.0
Leadership/Communications	.0	.1	.2	.5	.6
Total	1.2	15.1	25.6	25.9	12.8

Table 1. Allocation of AB 803 Funds to State Initiatives

Grants to districts and counties were of two major kinds. Adoption/expansion grants of $8,000 - $24,000 have been awarded on a competitive basis to approximately 65% of the states' public schools. These grants allow schools to set their own priorities and to make a modest start on implementing educational technology. To study the longer-term impact of full-scale implementation of technology, five sites have been designated as "model technology schools" and will receive $500,000 each year for three to five years to investigate the effect of technology on teaching, administration and organizational structure.

Regional support services were provided through the TECCs (see above) and seven Instructional Television Regional Agencies. The latter provide teacher inservice and have licensing and duplication rights for a wide variety of television programs.

Curriculum materials/program acquisition activities include the purchasing of licensing agreements with publishers of computer software and video programming and joint ventures with publishers to produce high-quality instructional materials that match California's curriculum needs. To ensure that maximum use is made of licensed video materials, in 1985 a video cassette recorder was purchased with AB 803 funds for every school in the state

A major AB 803 project is the production of *Technology in the Curriculum Resource Guides.* The first four guides - Mathematics, Science, History/Social Studies, and

English/Language Arts - were distributed to all schools together with sets of exemplary software. Two new guides, for Fine Arts and Foreign Language, were distributed in Winter 1988 together with updates to the first four guides.

Staff development is primarily supported through month-long Summer Technology Institutes for teachers offered at campuses of the California State University and the University of California.

The Office of Educational Technology provides leadership through implementing the initiatives described above and through a series of publications including *Computers in Education: Goals and Content*, a model *Software Copyright Policy*, *Guidelines for Educational Software in California Schools*, and *Computer Applications Planning*. A two-year, statewide pilot project to investigate educational uses of telecommunications is being planned. The State Department of Education, in collaboration with the Educational Technology Committee, is developing a Long-Range Educational Technology Plan for California Schools.

TEACHER CERTIFICATION

AB 1681 (Statutes of 1986) required that teachers receiving a clear credential after July 1, 1988 demonstrate competence in general and specific applications of computers to education. Every institution of higher education that offers teacher credentialling programs has to respond to this legislation and establish a way of providing these competences. In most institutions this will mean an additional required course in certification programs.

1987/88 AND THE FUTURE

On July 7th, 1987 the Governor of California exercised his line-item veto authority and removed all funding for TEC Centers (and several other staff development programs) from the 1987/88 state budget citing the need to balance the state budget and his desire to put money into classrooms rather than programs above and beyond those providing basic educational needs. At the same time the governor also vetoed half the funding for AB 803.

While some TECCs are continuing minimal services using carry-over funds, to all intents and purposes they have ceased to exist as a state-wide resource. Most rural areas and small school districts now have no support services for educational technology and, in general, do not have the resources to buy those services. The 1987/88 budget for AB 803 represents a holding pattern which continues the major initiatives but at lower funding levels.

The climate in which efforts must be made to replace services funded directly by the state is not especially good. The State is faced with a voter-imposed cap on overall spending, so the competition for funds is fiercer than ever. The public schools are growing at a rate of about 100,000 students per year, so this growth itself puts tremendous pressure on the funds allocated to education. This pressure is intensified by the trend to accelerate increases in teacher salaries. Several other politically "hot" programs, included gifted and bilingual education, as well as AB 803 itself will expire this year unless reauthorized.

So at the state level many initiatives will be set back by one to three years. But at the grass roots - in the states schools and through Computer Using Educators - there is still strong interest in making educational technology fulfill its promise. Many dedicated people worked at that dream before state funding was available and will continue to do so.

COMPUTERS AS A CATALYST FOR EDUCATIONAL CHANGE.

Brian F.Wray *

ABSTRACT

Following a successful introduction of a broad based approach to the use of microcomputers to improve the quality of teaching-learning in a Kenyan private school the Aga Khan Foundation is attempting to replicate the effects in a wider range of government schools. The philosophy, operations, successes and future challenges are outlined together with an indication of some of the more important constraints which hamper the growth of educational change, even without the severe financial limits placed on education. It attempts to show that computers will not only force an educational change but will act as a catalyst in resolving the future. The research effort associated with this project puts it amongst the most documented introduction of information technology in secondary schools to date, and one of the few in less developed countries.

INTRODUCTION

In 1982 the Paris based Secretariat of the Aga Khan Education Service (AKES) was concerned that they, and some of the pupils & teachers within their system, should gain experience of using micro-computers within schools. The semi-autonomous AKES, Kenya was able to gain the services of an implementor, and to present to the Secretariat, and the funders (AKF), an appropriately wide ranging philosophy for such an innovation for the Aga Khan Academy, Nairobi. The project would involve the whole school and attempt to use as many facets of this new tool so as to improve on the rote learning and didactic methods apparent in Kenyan schools.

As a result of three years experience of the implementation in a single school it was decided that a similar strategy should be attempted in a number of other schools, most of them government maintained. Five extra schools were originally choosen to receive equipment, donated by Apple Computer Inc., together with the necessary software, materials and in-service education for the staff funded by the Aga Khan Foundation, Geneva (AKF). Two further schools were added a year later (April,1987) after obtaining their own equipment.

The philosophy of AKF has always been to support initial projects in developing countries, insisting that they are well researched and documented so that if it becomes desireable to expand them other agencies or governments can proceed without the necessary research and development costs. Both the Rockerfeller Foundation and I.D.R.C. have become interested in the project and, with AKF, are supporting the research, which has already amasssed a large quantity of data. This research effort has helped with formulating necessary changes within an enlarged and different environment from the original school.

THE PHILOSOPHY OF THE IMPLEMENTATION

It is obvious that the computer will impinge on the life of the urban Kenyan child and at present good jobs are available for those with a minimum of skill. However the bald introduction of computer studies seems to be inappropriate if a wider use can be found which also re-motivates the children to learn and, possibly, the teachers to become more inspired and effective. Since children seem to be keen to try out innovative work at the computer it was decided that the major focus of the project would be to re-educate the teachers, not only in the use of the micro-computers, but also in the various new methods of teaching that are necessary for a child-centred approach and re-inforcing educational technology generally.

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The teachers were to be challenged to work out their own methods of incorporating this tool into their teaching and to experience for themselves the sense of discovery and joy in learning which many had lost. The implementation would focus on providing this expanding challenge, providing the means to discover answers and the guidance which would minimise, but not eliminate, mistakes. The path was, and is, left deliberately open; not only because there still appears to be no best approach to computers in education, but because most teaching seems directed at giving a 'correct' answer even when it is obvious that none exists.

Undoubtedly the teachers would prefer to be told exactly what to do, how to use the software and when. This training approach had been used during their own schooling, their college life and most of their in-service training. This didactic approach to the training of teachers may well be responsible for their own boring classroom methods, which are then transmitted to the next generation who originally approached school with great curiousity.

THE OPERATION OF THE IMPLEMENTATION

The full staff of each school was given a 70 hour introduction to the micro-computer, in August 1986, during which they covered most of the basics together with a sampling of the software possibilities. Although this started with some lectures, almost 60% of the time was spent in hands-on experience in groups of 4-5 people. These were deliberately mixed subject groups, usually, since most teachers appear isolationists in both their own learning and in what they expect from the children. In a country which has the motto "Harambee" (cooperative self-help) the concept of group learning is surprisingly missing from the teachers' methods of classroom management. The staff were then asked to discuss what they had learnt and to attempt to put this into the school perspective. During all discussions the model of a child centred curriculum was maintained by the implementor as opposed to a subject centred model held by most teachers.

Since secondary schools are severely subject bound it is necessary to provide more workshops with a definite bias. In most cases the weekend workshops were arranged on a faculty bases, since it appeared that teachers had very little idea of what went on outside of their own subject. These were Sciences (including Agriculture), Languages (English, Kiswahili & French), Social Studies (History & Government, Geography, Social Ethics & the religions), Commercial Subjects (Economics, Commerce, Accounts, Office Practice etc). The idea of cross subject teaching being so foreign that it was, at first, dismissed as impossible since they were constrained by their own subject needs and knowledge. Mathematics seemed to demand a seperate 16-hour workshop, which focused on LOGO, graphical solutions and some ideas on divorcing calculation techniques from concept acquistion so that the pupil may concentrate on the latter.

During the continuing monthly visits by project personnel it became obvious that each school had several people who became really interested in the uses and the possibilities of the computers. Surprisingly these emerged from eight different subject backgrounds and in over half the cases were not the people who the Headteachers of the schools had expected. This underscored the need to expose all the staff to the initial workshop, not just a choosen few, especially where there is little or no prior public exposure to the technology. After six months these teachers were given a 40-hour workshop with more detailed exposure to the technology to fit them for a role as equipment 'experts' to be of immediate help to their colleagues. This enabled the Headteachers to delegate responsibility for this area of their school to more knowledgeable staff. Since then these teachers have been provided with further opportunities to improve their own knowledge so that they can make a greater contribution to their schools without the constant need for central intervention.

A number of more specialist workshops were held to see how far it would be possible for teachers to author their own software in Pilot; using LOGO for problem solving; financial control using a spreadsheet; examination analysis using various techniques.

To counter-balance the challenge of the problem solving approach of the innovation various methods were provided to lighten the teachers normal job. By using the word processing facility the teachers can produce good notes more easily, by using graphics packages they can produce better diagrams, by using a database they can spend less time on clerical functions etc. Some of these tools also enabled the administration to function more efficiently, and thus allows them to provide a better support to the teachers and children, removing many frustrations.

Several weekend workshops were held to provide the necessary insights into the possibilities opened up in the management of the learning process, in particular in analysis of student progress. The Headteachers are a necessary target for enlightenement and change since they can exert tremendous influence in a society which is hierachically orientated. Unfortunately most are submerged in routine matters, much of which has little to do with educational issues. It has been possible to challenge them to rethink their role and to provide them with the tools to help shift some of their work to others whilst gaining better information about their schools.

PRESENT SUCCESSES & FUTURE CHALLENGES

Four terms after the schools received their original workshop there was a considerable difference in their progress. The number of teachers who regularly use the computers ranged from 2(7%) in one school to 15(45%) in another, whilst the original school showed a similar high level of use despite major staff movement. The average percentage of regular teacher users for all schools was 19%. The major uses are in applications which make the teacher more productive and/or the material presented more effective. The pupils have benefited by receiving more good quality handouts, thus spend less time copying from the blackboard. There has been some move to making the classrooms more interactive and less directed. Several sets of teacher's notes appear to be heading towards textbook status due to the easy at which they can be refined and improved with experience.

At present very little use has been made during class time of the extensive CAL software available. However the material has been viewed by teachers and some has been seen by pupils after school. Some teachers have thus discovered ideas which they now use in their normal teaching, whilst beginning to appreciate that the technology has its uses. Computer clubs have been established in all schools providing activities which range across programming, graphics, games and magazine production. Some older pupils have been encouraged to try a particular piece of software by their subject teachers, whilst others have tried out CAL material for themselves. In many cases they appear to have successfully learnt lessons which their teachers had rejected as being too advanced or inappropriate. Striking popularity has been achieved by some revision programs in science which students credit with helping them in final examinations.

The schools have yet to tackle the problems associated with class management of 40+ pupils and a maximum of five computers. In contrast, after two years, the original school administration conceeded to the teachers' demand for more space by removing a wall between two rooms and buying special tables which now allows for more class activity in the room. This resource centre is now used to its capacity, in fact there is often a small senior group in there in addition to a junior class. It seems too early still for the critical mass of teacher opinion, including management encouragement, to appear in the new schools for the successful change in their educational ethos. There are signs that several teachers would now desire this change in the right circumstances, but are unsure of the social-political climate in the school. This is largely controlled by the pressure for results in, and the uncertain nature of, the new final examination.

Most of the bursars make extensive use of the tool for their accounting, using the spreadsheet side of the integrated AppleWorks package. There has been considerable creativity shown to create computerised versions of the Ministry demanded accounts records for fees, payments, stock control, trial balances and payroll. Several secretaries with their bosses now do their reports on word processor and provide the various lists on the database of the same package. This integrated software is extremely successful in providing a variety of task solutions for a variety of people without causing a large number of different learning situations.

It must be emphasised that schools require robust, good quality, easy to use and easy to remember how to use software. When the command structure is matched across a number of different applications then it is more useful. Since tasks range across a very wide spectrum the software needs to be better conceived than that required for commercial use where one person may only use a few packages.

CONSTRAINTS TO PROGRESS

Many factors can be identified as constraining the progress of this attempt at educational change. There would appear to be four groups of people who need convincing that the change is worthwhile - the children, the teachers, the administrators and society at large. The factors which need addressing include ①the need for change, ②the fear of change, ③time constraints, ④re-thinking of attitudes and ⑤the examination system. The groups and factors are linked by a complex network, but the greatest cause for concern would appear to be with all groups, other than the children, and especially with the first and last factors.

The examination system must change to obviously test for understanding and thinking rather than regurgitation of facts. This has already happened in Kenya at the Primary level, but teachers, and hence children, do not believe it is going to happen in the new examinations for 1989. The national goals for Secondary education were clearly stated in 1984 at the start of the new 8-4-4 system and pointed to a broader type of education, with less emphasis on acquistion of pure facts and more on self-reliance & adaptability, but these seem to be rarely considered by teachers or heads. However it will require greater innovation on the part of examination bodies to create tests for competence at secondary level since these will need to be much more diverse whilst be aimed at skills which have always been notoriously difficult to examine on mass in the short time normally allocated. Society will also have to agree to accept this change.

Hence the people in schools do not believe there is any need for change - they were programmed with the facts when they were young so why should not the school be like some OPROM (Organic Programable Read Only Memory) factory. They also have a massive fear of change since their jobs, philosophy and prestige are on the line, and hence they will invent many difficulties to hinder the change. So the problem of time appears in many guises, from the impossibility to complete syllabi to the need to mark books etc. Rational methods of saving time by using the computer are viewed with suspicion even when they appear to work. Society itself is fairly certain that change is needed, but is not at all sure what those changes should be and so would like the professionals to make the decisions. Since many of these professionals are subject based University professors it will require them to recognise the faults in the lower educational system caused by their desire for subject specialisation within secondary schools. However many of the teachers and observers of this project are begining to see new vistas of possibilities which, in time, may help the next generation solve some of the educational difficulties now apparent.

It may well be that the secondary school itself, a product of the industrial revolution, is an outmoded form of educational establishment that requires a different format in the light of advancing information technology. Some people are advocating a more robotic approach to education by using class sets of computers which will enable the programming of children to be carried out more successfully. Others are devising methods of adapting the small screen size to once again put the teacher in front and directing the class. We believe that it is possible for the computer to play a major part in making education more humane, especially at the secondary level, by allowing the pupil to control his own rate of learning, whilst the teacher helps the pupil to develop their learning strategies. We need to marry modern technology with the Ancients' concern with the growth of the individual mind through interactive discourse.

Disclaimer
The above opinions are those of the author and do not necessarily reflect those of any organisation with whom he has affiliation.

EDUCATION & COMPUTING - TRANSLATION RESEARCH OUTCOMES INTO EDUCATIONAL POLICY

J.J. Beishuizen*)

INTRODUCTION

The 1980's will enter history as the decade in which computer technology began to be introduced in education on a large scale. In the year 1987 we can only see the early effects of this change. The way the introduction takes place bears some resemblance to a revolutionary movement, both in a positive and in a negative sense. The enthusiastic declaration of new possibilities in the teaching/learning process, new ways of independent and self-directed learning, new possibilities to adapt the learning situation to the individual student's needs, are definitely positive aspects of the integration of computers in education. The actual, rather chaotic situation is such that different and incompatible equipment and software is being used in schools, while standards of hardware and software are continually overthrown by new technological developments. At the moment the real bottleneck is in the development and production of suitable curriculum resources in which the computer serves as an aid. Unless efficient strategies are adopted, the quality of courseware will stay at a low level on which the dreams of a new era of education with the help of computers cannot be fulfilled.

Unesco Joint Studies in Education were founded in 1980. In June 1980 the Third Conference of Ministers of Education of Member States of the European Region of Unesco in Sofia, adopted a recommendation requesting member states to carry out joint studies of a comparative nature on well-defined problem areas of common interest in the field of education. In 1981 topics for joint studies were considered. At a meeting of experts of European National Commissions for Unesco, organized by the Austrian Commission for Unesco in cooperation with Unesco, and held in Vienna, March 31 - April 2, 1982, fourteen subjects were agreed on for joint studies.

At the Vienna meeting Study 3 was identified as "The use of the (micro) computer in the teaching learning process". The duration of this study was planned to be three years. The Netherlands took responsibility for the coordination of the project. The following countries took part in the study: Austria, Canada, France, Hungary, The Netherlands, Union of Soviet Socialist Republic, United Kingdom.

Study 3 aimed to provide a state-of-the-art overview of the way in which the microcomputer is being used as an aid in the teaching and learning processes in primary education, secondary education and special education. Well aware of the fact that technology is still in the process of rapid development the participants of Study 3 decided to emphasize issues related to the teaching/learning process and the role of the microcomputer in the curriculum of several strands of formal education. Study 3 focussed its attention on three major changes to be expected from the introduction and use of information technology in education.

1. Changes in the teaching and learning processes. The microcomputer is widely regarded as a potential tool for facilitating and effecting change in teaching and learning processes. The question is whether the microcomputer will cause revolutionary changes to occur in the learning of factual knowledge, the learning of cognitive, affective and motor skills, in the learning of concepts and rules, in problem solving, creativity, language development, etc.

2. Changes in the role of the teacher and the learner. The use of the microcomputer in education may change the role of the teacher. The teacher's role may be more that of a facilitator than of a person who initiates and directs all activities in the classroom, especially in those situations in which the computer is employed to enrich the learning situation. Also for the student several changes may be expected as a result of the use of the microcomputer in education: new kinds of learning experiences may become available in regular education (e.g. problem solving by programming, learning by doing through simulation and modelling), relationships between students and teachers may change, student motivation (intrinsic learning motivation, aspiration level, fear of failure) may be influenced, attention span and concentration level (sustained attention) may be enhanced.

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3. Changes in the curriculum. A number of questions were addressed under this topic: Which subject areas (in particular outside the field of mathematics and sciences) are actually being supported by computer based learning? Which part of the curriculum is devoted to Computer Literacy and Computer Science? Should Computer Science be taught as a subject or should the computer be used as a tool? Which grade levels are most suited to the introduction of computer awareness?

FOUR MAJOR ISSUES

The materials brought together by the participants of study 3 addressed four major issues: (1) Microcomputers and skill development; (2) Integration of the microcomputer in the classroom; (3) Teacher training; (4) Courseware development and evaluation.

1. Microcomputers and Skill Development

The use of microcomputers in skill development will greatly enhance the possibilities to design rich learning environments enabling students to learn by active exploration. The development of general skills for learning, problem solving and information handling will become part of the educational objectives of primary, secondary and special education. However, this change in the teaching/learning process and the curriculum will not succeed unless precautions are taken. Firstly, a careful balance must be sought between creating opportunities for free exploration in the learning environment and providing guidance by showing examples of skilled performance. The choice of examples and guidelines and the optimal equilibrium between the expository and discovery modes of learning depend on the individual student's abilities and learning characteristics. Therefore, teachers have to learn many new skills in order to become flexible facilitators. Secondly, the computer itself should not only control and maintain the learning environment but also be equipped with feedback facilities. A learning environment should be responsive to the individual student's needs at any moment during the learning process. Unless these two conditions are met we have to face the fact that the introduction of the computer might actually enlarge the gap between (socially) privileged students and their less fortunate colleagues.

2. The integration of the microcomputer in the classroom

The integration of the microcomputer in the classroom is probably the major problem formal education has to envisage for the next decade of implementation of information technology in education. Teaching strategies must be reconsidered in the light of the use of microcomputers as a powerful educational means, and creating effective learning environments characterised by individualisation and autonomous learning of subject matter knowledge and heuristic problem solving skills and creativity. In order to realise these potentials a number of conditions must be met. A crucial practical condition is the way the equipment is installed in the school. Less positive teachers might easily be discouraged by practical inconveniences which so often accompany the distribution of microcomputers within education. The role of teachers using microcomputers will change. They no longer are the origin of most initiatives and decisions. Instead, they facilitate the learning process by giving advise at the proper moment. They can closely observe the students' accomplishments to get a clearer idea of the difficulties in the learning materials. As the issue of integration of microcomputers into the classroom is considered of paramount importance, not only conference agendas, but also bulletins issued by schools show signs of the need of teachers to share their experiences with colleagues facing the same situation.

3. Teacher Training

Teacher training can be defined as generating enthusiasm of teachers to change their role in order to improve student performance without diminishing their commitment to the process of teaching and learning. Again and again it should be emphasized that reality is often resistant to change. To prepare them properly during preservice training teachers should be confronted with the problems to be expected. They should learn that the integration of the microcomputer is a matter of major concern. After an initial phase of preservice training inservice courses should be provided where teachers in the same field might work together on practical problems. Both preservice and inservice training should preferably be given by experienced teachers, able to disseminate and evaluate classroom experience. To overcome possible problems of shortage of experience, the "multiplier" approach (see issue paper) might be applied.

4. Courseware Development and Evaluation

A clear statement of what is meant by high quality courseware serves as a proper point of departure for further in-depth discussion of adequate strategies of courseware development and evaluation. In the issue paper high quality courseware is defined as: "Courseware, having its origins within a curriculum context, which facilitates and can be readily, appropriately and effectively integrated into classroom activities, enhancing and improving pupils' learning experiences and which reflects the best that can be offered by currently available technology and publishing techniques.". Courseware developers have to keep in mind three goals which are not always congruent: (1) good courseware provides a solution for existing students' problems or needs; (2) good courseware draws on the educational capacities of teachers but does not overask them; (3) good courseware uses the possibilities that information technology offers. Whilst seeking a careful balance among these three goals the students' problems or needs should be considered as prevalent. Courseware should be developed by interdisciplinary teams bringing together expertise from different disciplines: educators (teachers, psychologists, curriculum studies advisers and evaluators), computing personnel and specialists in the area of graphics design and the layout and presentation of text, equipped with adequate resources. Both the hardware and the programming environment should allow a professional way of software development. As far as the development methodology is concerned an interactive approach is recommended in which design, evaluation and redesign follow each other until an adequate product is realised. The educational validity and acceptability of courseware should be determined through trials within the classroom, involving external evaluators.

CONCLUSIONS

How to translate these conclusions into educational policy

From the point of view of countries participating in Study 3, it is difficult to judge which conclusions and recommendations of Study 3's report are relevant to and useful for educational policy makers working in developing countries. One has to take into consideration the differences in educational system and infrastructure. The priorities not only differ between Study 3's countries and developing countries but also between developing countries themselves. Any educational reform, be it with or without information technology, should choose the local educational priorities as its point of departure.

Byway of example a short description is given of the collaboration between the Free University of Amsterdam and three universities in Southern Africa: the University of Botswana, of Swasiland and of Lesotho. Two local priorities hold (differing in weight of importance between the three locations): (1) Development of an elementary Computer Science Course at university level, and (2) Extension of the so called Pre-entry Science Courses (aimed at reduction of differences in entry level of university freshmen) with computer based learning units. For these two purposes Dutch courseware materials are currently being translated and "transplanted" into the educational structure of the three African universities. The provision and testing of courseware materials is to be considered as the first step. The local teachers are offered the opportunity to start working with the computer in education. A thorough evaluation of this approach is planned. The next step should be: providing preservice and inservice courses for all teachers in the lower levels of university education. These teachers should be prepared to develop new applications in education, initially by adapting existing materials, eventually by participating in local development activities. The third step might be the preparation of a local infrastructure to enable the local development, production and evaluation of courseware materials. Later on, the proper integration of the use of the computer in the existing (or renewed) curriculum should be taken into account, as well as the proliferation of experiences to other levels of formal education. It should be pointed out that of the steps proposed here only the first is part of the agreement between the universities in Amsterdam and Southern Africa.

The problems to be expected in the steps outlined above leading to full implementation of computers in education are probably not completely different from the pitfalls and stumbling blocks mentioned earlier under the four headings of Microcomputers and Skill Development, the Integration of the Microcomputer in the Classroom, Teacher Training, and Courseware Development and Evaluation. The introduction of the computer in the process of teaching and learning is as "new" in the developing countries as it was in the industrialised countries a decade ago. Some transfer of experiences should be encouraged to prevent the re-occurrence of wrong decisions and ignorance which impeded the first attempts to turn the computer into a useful instrument in the hands of both teachers and students.

USING TECHNOLOGY TO TEACH LIFELONG SKILLS

J.R.Anderson[*],D.Gess[o],P.Hale[+]

ABSTRACT

East Ramapo's Communication Center Network has sites in each of eight buildings housing grades 4-8. Using a telecommunications network system, students have opportunities to utilize computers, printing and binding equipment and modems. Through teacher and peer instruction, students create publications, share data or information with network schools and participate in activities which develop problem-solving skills. The Communication Center concept provides students of all educational levels with the motivation to improve communication skills. Evaluations of the program reveal improved writing and verbal skills as teachers and students increase time on task. Opportunities to communicate with students in other schools, to publish their work and to retrieve data from a variety of networking sources have proven to be highly motivating for both students and teachers. The success of this program has led the New York State Legislature to provide funding for the District to expand this program to students in grades K-3.

INTRODUCTION

Today's technology uses telecommunication for a variety of purposes, among them is the motivation of young people to learn. With the added goal of teaching young people lifelong skills, our school district has embraced the new telecommunication technology by creating a Communications Center Network Program. This program has as its primary goals:

- *The motivation of writing for publication as impetus to improve students' reading and writing competencies*
- *The improvement of the quality and quantity of students' writing products*
- *The encouragement of students to use telecommunication skills as a vehicle for accessing data as a lifelong operational process*
- *The training of teachers to be facilitators in the delivery of writing, publishing and researching.*

THE PROGRAM

·*The motivation of writing for publication as impetus to improve students' reading and writing competencies.* Motivation for student publishing is fostered through the use of laboratory or classroom based microcomputers to type drafts which can be illustrated and published at the buildings' Communication Center. This final document achieves a professional look through the use of Macintosh computer software and binding equipment, which delivers the students' own bound published books. The

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sharing of these completed books by cataloguing them into the school libraries gives other students an opportunity to read what their classmates have written. Through this process, reading and writing are connected, and students are motivated to publish additional work.

·*The improvement of the quality and quantity of students' writing products.* Teaching of keyboarding and word processing beginning at the primary grades helps students write with a level of comfort, eliminating the time-consuming "hunt and peck" system. The use of a computer projection device as a time-effective method of large and small group instruction allows teachers to present skills with follow-up remediation instruction done on an individual basis with children at their respective computers. Through the use of computers, our staff is able to teach our writing program's editing strategies (Project WRITE) as an integral part of computer instruction. During computer time, students learn to expand, delete, substitute, and move and rearrange as they work through drafts in readiness for publishing.

·*The encouragement of students to use telecommunication skills as a vehicle for accessing data as a lifelong operational process.* Future success of students will depend in great measure on their skills and abilities to successfully manage information. Our technology program instructs students and teachers how to access on-line commercial and noncommercial resources for retrieval of data and dialoguing for the sharing of information. This activity is particularly helpful in suburban or rural areas and allows students without transportation to a library to still have the ability to retrieve information. Through information sharing, students are able to link with other students from diverse cultural backgrounds and geographic locations as a way to do research in social studies or other subjects. By learning the etiquette and language of "expert conferencing" students have the opportunity to engage in on-line dialogue with an expert from a particular field thereby bringing community, national or international experts right into the classroom. Our program gives great potential for learners to become familiar with existing and newly-developed research strategies. Among the skills experienced is the ability to discriminate between and among a variety of on-line reference sources for the successful retrieval of appropriate data. This skill would be evident when students correctly select and search only those data bases which provide pertinent information.

·*The training of teachers to be facilitators in the delivery of writing, publishing and researching.* The philosophy of staff development we have followed throughout this program has been to start with training those teachers who show an interest in the new technology. Staff development continues as these motivated teachers serve as turnkey trainers for department or grade-level colleagues. Subsequently, the reactions to published materials have led to other reticent teachers becoming involved. The grassroots approach and peer tutoring have fostered an enthusiastic acceptance of our Communication Center Network Program. As we move further into the technology era in our district, we anticipate continuing the Teacher Center workshops and seminars. The new Teacher Center-sponsored bulletin board system will serve as a clearinghouse and management system for communication, thereby tying all the building Communication Centers together.

PHYSICAL DESCRIPTION OF COMMUNICATION CENTER NETWORK

Each of the elementary and junior high schools in our district are tied into our Communication Center Network Program through the acquisition of equipment, which includes one or more Macintosh computers, printers, compatible software, a modem, binding and reproduction equipment and a computer projection device.

The Center's equipment is kept in one of three locations in each building: the library, computer lab or school workroom. In addition to this equipment, the microcomputers in both the classrooms and the labs are used to produce rough drafts of materials, which are then brought to the Communication Center to be published. Lessons in keyboarding and word processing, taught as part of the communications program, are delivered through large or small group instruction using a computer projection device which projects computer images onto a screen from an overhead projector.

Initially, the only telecommunication possible was when one microcomputer was connected to another microcomputer with a modem, software and telephone line. This required prearrangement by voice (phone) contact. It became obvious that a more productive and universally-adaptable method could be implemented. At that point, the Teacher Center incorporated into its funding the establishment of a district-wide bulletin board system to serve as a place for sharing and transferring information. The bulletin board, located at one of our high schools, is available 24 hours a day. To initially prompt teacher use and to enable teachers to become aware of the vast possibilities of telecommunications, information of personal and professional interest was posted on the system. Following their first encounter with bulletin board telecommunication, teachers comfortable with the technology used the bulletin board system with groups of children for "expert conferencing" and electronic mail. We currently have a subscription of Bibliographic Retrieval Service and the next step is the purchase of subscriptions to other commercial services which provide electronic libraries, e.g., Compu-serve, Dow Jones data bases that businesses and schools use for research purposes making available the equivalent of paper stacked the height of the Empire State Building. The Dow Jones New Retrieval Service connects the user with 35 data bases containing full text of the Wall Street Journal, Washington Post, electronic encyclopedia, college selection service, up-to-the-minute news, weather, sports coverage, electronic household and airline ticket shopping and current movie reviews. The training of our staff will continue as the building Communication Centers are provided with these enlarged data retrieval services.

Whereas our original computer-to-computer telecommunication link was limited to two participants, this new Teacher Center-sponsored electronic bulletin board system will provide a public forum capable of raising issues and encouraging a broader population to respond.

SUMMARY

Teachers are responding to motivating, educational activities and lessons using on-line data bases and other features provided by the bulletin board system. The cognitive skills inherent in the teaching of reading, writing, social studies, science and many other curriculum areas provide a promise of support from exciting new resources. Classes may participate in activities ranging from a search from the Dow Jones data base on early explorers to weather and sports coverage and may also dialogue with experts, such as published authors. With this data in hand, students or classes can complete assignments using the components of the Communication Center to publish and illustrate their reports in a matter of hours.

Will the technology taught in our schools make a difference in the lives of our students? We think it will bring them into the rapidly changing post high school world with skills necessary to place our students in a position of strength and in direct line with success.

A COMPARISON OF COMPUTER SCIENCE PROGRAMMES IN SOME ADVANCED COUNTRIES

P.K.H. Phua*

ABSTRACT

In line with the national effort to promote and develop computer software and services industry in Singapore, a study team was recently set up to undertake the study of educational and training systems at the college-level or equivalent level in modern institutions in countries well-developed in computer and information technology. Some 17 institutions in three countries: USA, Canada and West Germany were visited by the study team. Some important observations and findings on the curriculum, teaching aids, and computer facilities of these institutions are discussed in this paper.

INTRODUCTION

The national effort to promote and develop computer software and services industry in Singapore forms an integral part of this country's economic restructuring programme in the 1980's. Singapore, already a significant economic strength within the ASEAN and the Far East, looks forward to becoming one of the world's leading software centres. An important part of this effort is the development of manpower which is sufficiently trained to serve the growing needs of the local industry. The training institutions in Singapore must play a key role in educating young Singaporeans, and prepare them for professional careers in computer and information technology. As the ground work had been done largely on the basis of local experience and materials gathered, the study group considered it necessary to undertake study visits to a number of institutions in advanced countries in order to compare its proposal with contemporary facilities and training systems. Some 17 institutions in three countries: USA, Canada, and West Germany were visited, some important observations and findings are reported in this paper. Due to the limitation of space, we can only select one representative institution from each country for further discussions.

COMPUTER STUDIES IN SOME ADVANCED COUNTRIES

All community colleges in the States practice the Credit Systems. Students are encouraged to choose their own preference subject combinations in addition to their major subject of study. Hence, the community college graduates in the USA are specialized and at the same time, versatile. Admission requirements for enrollment however vary from states to states. Upon the completion of their studies in

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computer science from the community colleges, students will be awarded the Associate Degree in computer studies. The majority of the courses offered in computer studies are transferable to other universities in the USA. Thus students may spend their first two years of study in the community colleges and the transfer to a four-year institution to complete a Baccalaureate programme in computer studies.

The Information and Computer Science Department of the Leeward Community College in Honolulu offers the Associate in Science degree. The curriculum leading to this degree is designed to prepare students for employment as technical assistants to professional and administrative personnel using computers. Students are required to complete at least 60 credit units of course work. Students are expected to take five courses each semester, and they have to spend at least two hours per week on the terminal for each programming course. The teaching load for each full-time staff is about 15 to 20 credit-hours per week. There are some 200 studnets major in computer studies, and the size of each class is about 30-40 students. The computer center of this college has an IBM System/3 model 10, and they have some 20 remote terminals attached to an HP3000 and a CDC Cyber computers located in the computer center of the Hawaii University in Honolulu.

The Business and Computer Studies Division of the Sencca College in Toronto has designed its curriculum content to reflect the needs of all aspects of commerce and industry. A number of advisory committees comprised of representatives from industry and professional associations, work closely with curriculum co-ordinators to ensure that course contents are related to job opportunities. The Division has structured its course programmes in order to allow students the widest possible latitude in selecting a career study programme. The computer studies courses are oriented towards business and commercial applications with the objectives of providing training for employment and in general principles on which the skills are based. Graduates from the Computer Programming and Analysis (CPA) course normally begin their careers as programmers or systems analysts. Graduates from the Computer Programming and Operations (CPO) course normally begin work in computer operations or programming.

A very successful Co-operative Education Programme has been made available since 1978 to all students in the CPA program. The Co-op program formally integrates academic study with semesters of meaningful productive work experience in co-op employers' computer installations. Following successful completion of their third semester professional subjects, students alternate semesters of work with study. Successul completion of each work semester, grades are assigned through employers' evaluation of the students' job performance, completion of an activity log and College grading of work reports. Employers pay Co-op students part-time rates for the specific jobs held, thus adding the important element of employee accountability to the Program.

The first computer in West Germany was installed in 1956. Twenty years later, there were some 25,000 computer installations and 300,000 job positions in the field of data processing (DP). In the last few years, the annual growth rate for job opportunities in the DP field is about 31%. It is estimated that the annual demand for DP professionals is about 10,000 in the country. Scuh a trend of development introduces certain serious side effects for DP professionals in regards to their corresponding qualifications and trainings. Many computer professionals coming from other various training disciplines are not really capable for this ever changing and challenging working environment. It is therefore felt that good training facilities must be provided to those persons who desire to choose DP as their future careers. Taking all these into considerations, the Fachhochshule des Lands Rheinland set up its Department of Computer Science in 1978, and it provides people living in Worms with a unique opportunity to do their studies in computer science in conjunction with business studies.

Depending upon the choice of indiviudal students, the Department offers two specilized programs: General Computer Science (GCS) and Economic Computer Science (ECS). The emphasis of training in the GCS program is to stress on the technical applications of computers in both natural and social sciences. While for the ECS program, the specialization is directed towards the economic significance and business management areas. The program is basically divided into two study phases, and each study phase consists of three semsters. Students are expected to take about eight courses per semester, and this added up to about 82 credits per study phase. After their graduation, students will attain sound computer science knowledge to become DP professionals such as DP organizers, software specialists, economic consultants, programmers, or systems analysts.

RECOMMENDATIONS

In the report of the National Computerization Committee (NCC) on October 1980, the Committee emphasized that the promotion and development of the computer services industry will form an integral part of Singapore's economic restructuring programmes for the Eighties. By 1990, the projected number of computer personnel who are programmers, systems analysts, or DP managers will be between 5800 and 7800, representing an eight fold increase from that of the 1980's. The severe shortage of software personnel must be alleviated by a co-ordinated programme to train the necessary number of EDP personnels at all levels to meet the needs of our computer industry. This would also enable the EDB to promote Singapore as the centre of Computer Software industry in the region. The proposed institution will offer Computer Studies programmes up to the technician level, complementing the programmes of the National University of Singapore (NUS), Japan-Singapore Institute of Software Technology (IST), and Institute of System Science (ISS). Since the computer is the most powerful tool yet developed to process the massess of information in the increasingly complex business organizations of today, it is therefore strongly recommended that the curriculum of this Department is set up in such a way that it will meet the myraid needs in Computer, Business and Industrial areas.

Keeping the above arguments in mind and taking the relative merits of the Computer Studies programmes offered by various institutions considered in the previous section a detailed curriculum is proposed by the study team for the implementation of a two-year and three-year programmes in computer studies, for college students. One major modification in the curriculum for the 3-year programme is that the course structure of the first-year study is designed to upgrade the communication skills and academic background of the 'O' levels students. It is hoped that after this first-year of studies, the academic standards of 'O' level students in both English and Mathematics will be compatible to those students with 'A' level certificates. After their first year of studies in the college, the 'O' level students will now be able to attend common classes together with the 'A' level students. That is, the curriculum of the second and third-year programmes for 'O' level students will be identical to that of the first and second-year programmes for the 'A' level students respectively.

The new proposed curriculum is furnished with specific course titles, additional subjects, professional options, adjusted lecture/tutorial/practical hours. In order to support and to enhance the teaching activities of the Department, it is suggested that a separate Computer Centre should be set up. The specifications of the computer hardware and software requirements are included in the recommendations. Various Computer Laboratories are also required to set up in order to supplement and to complement the existing facilities in the Department as well as in the Centre.

LEARNING AND TEACHING WITH INTERACTIVE VIDEODISC

M.J. Atkins* and G. Blissett*

ABSTRACT

Recent work in cognitive psychology enables us to develop a model of how people learn. We can then use the features of the model to evaluate how effective interactive videodiscs are likely to be as learning environments. At present the potential may be limited, but in the future the possibility of integrating artificial intelligence applications looks promising. Even though present discs are less than perfect, it is still worth analysing the way learners work with them and the extent to which the learning goals are achieved.

INTRODUCTION

How do you learn ? Any examination of the potential of interactive videodiscs requires an answer to this question. Yet it is hard to answer for at least three reasons : we do not know that much about how the brain works; the concept of metacognition or 'learning to learn' is still being developed; and what counts as learning is to some extent culturally and socially determined - it varies across time and across context. Nevertheless, it is possible to develop a model of learning which synthesises recent work in cognitive psychology.

MODEL OF LEARNING

The model of learning presented below (ref 1) is based on the notion of the actively processing learner who, while endeavouring to relate new material to pre-existing knowledge and understanding is likely to restructure that knowledge and understanding to some extent. It is a model which lends itself to the metaphors of maps, nodes, links, and networks and to the basic concept of a self- organising system. The model owes much to the work of Marton (ref 2), Entwistle (ref 3), and Pask (ref 4) , each of whom has, using different methodologies, contributed to the understanding of styles, strategies and skills of learning. Their work suggests strongly that there is no one universal way of learning. Rather, there are several fairly stable orientations to learning. Different learners use different strategies on the same task, and the same learner may have a sufficiently large repertoire to select different strategies for different tasks.

If this model is reasonably accurate, then there are considerable implications for the design of learning tasks and the need to allow individual learners to adopt different routes through them. The model also draws attention to the importance of the learning context and a learner's perception of it. The way students perceive themselves, and the way they account for success and failure on a task, exert a strong influence on motivation and performance. Students are likely to initiate learning, sustain it , direct it and actively involve themselves in it when they believe that success and failure are due to factors within their own control (ref 5). Giving students a sense of responsibility for their own learning, and helping them to develop self-management skills, can be important.

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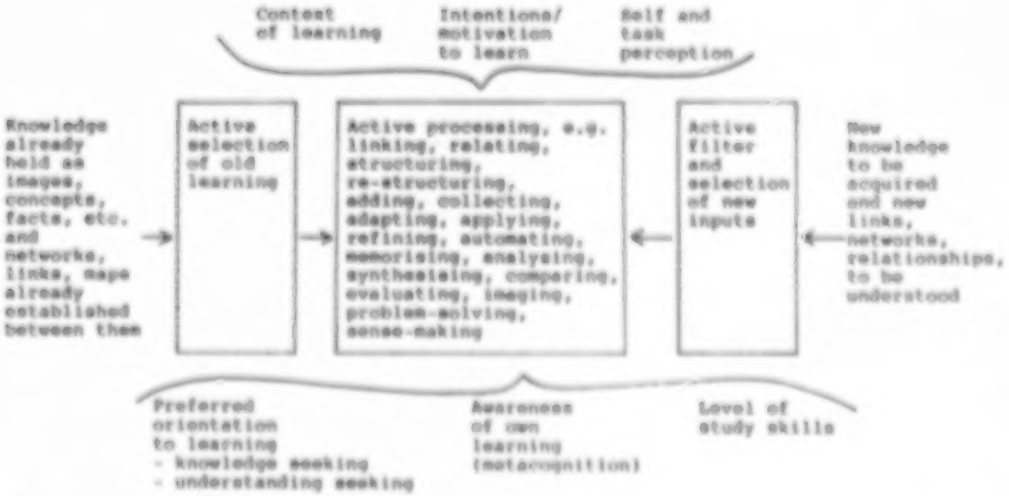
A MODEL OF STUDENT LEARNING


Context of learning
Intentions/ motivation to learn
Self and task perception
Knowledge already held as images, concepts, facts, etc. and networks, links, maps already established between them
Active selection of old learning
Active processing, e.g. linking, relating, structuring, re-structuring, adding, collecting, adapting, applying, refining, automating, memorising, analysing, synthesising, comparing, evaluating, imaging, problem-solving, sense-making
Active filter and selection of new inputs
New knowledge to be acquired and new links, networks, relationships, to be understood
Preferred orientation to learning
- knowledge seeking
- understanding seeking
Awareness of own learning (metacognition)
Level of study skills

If learning is seen as the product of interaction between the personal attributes of the individual learner, the different learning processes to which he or she is subjected, and the structure of the learning task in hand, then the job of the teacher is complex. The teacher must manage the learning environment so that individual learner and task are well matched and the learner is motivated. This requires skills of diagnosis and task design. Matching is not, however, a simple matter. For example, one can match a task to the existing cognitive level of the learner, or one can decide to design the task so that it encourages the learner to develop a new, higher level of competence and understanding. In the latter case, the matching will not be congruent with the learner's initial state. Further, the teacher must know when to intervene in the dynamic learning process to support, challenge, remediate, suggest, assess and provide feedback. And these skills are additional to the basic skills of explaining, questioning, listening and responding.

CHECKLIST FOR EVALUATION

On the basis of the analysis above, one can begin to develop a checklist with which to evaluate the learning and teaching potential of interactive videodiscs. Such a checklist might include the following questions :

- can the software diagnose what the learner already knows and how that learning is organised ?
- can it analyse a learner's preferred learning approach and adjust the presentation of material accordingly ?
- can the learning tasks be structured in different ways ?
- how much control , responsibility and choice does the learner have ?
- can different learning strategies and styles be used ?
- does it encourage in the learner an awareness of his or her own learning ?
- can it match the learning experience to the learner dynamically ?
- is there provision for assessment and feedback ?
- to what extent can it 'listen' and respond ?
- how good are the explanations offered ?
- how good are the questioning techniques employed ?
- is there provision for different types of matching ?

(These questions are perhaps only fair for those discs which claim to be the basis for stand alone self-study. Where discs are designed to be used alongside conventional teaching methods then the question has to be the extent to which the disc enables a teacher to achieve the desired learning environment.)

In theory there is no reason why an interactive videodisc could not be designed to satisfy all the criteria in the list.* It would almost certainly require, however, the integration of artificial intelligence elements, such as intelligent tutor systems. At present, in practice, the learning potential of interactive discs is more limited. Nevertheless, it is worth examining the way learners go about using such discs, and the extent to which the designer's expectations of learning are realised. In the conference session, the results of a carefully controlled study of pupil learning with interactive videodisc will be presented. The pupils were grouped by gender and ability and undertook a range of problem-solving tasks presented on an interactive videodisc. Videorecordings were made of each session and the pupils were interviewed both about their experience of using the disc and about the learning strategies they employed. Content analysis techniques were applied to the videotapes and the interview responses.

* For a discussion of the application of such a checklist to the design of interactive videodiscs see the paper by J. Mashiter 'Planning, Piloting and Producing an interactive videodisc'.

This paper arose from work connected with The Interactive Learning Project which is funded by the Nuclear Electricity Information Group.

References

1. G.A. Brown and M.J. Atkins, Effective Teaching in Higher Education (Methuen, London, 1988)

2. F. Marton, 'How students learn' in N.J. Entwistle and D. Hounsell (eds) How Students Learn (University of Lancaster, Lancaster, 1985).

3. N. Entwistle, 'A Model of the Teaching-Learning Process' in J.T. Richardson et al. (eds.) Student Learning. (SRHE & Open University, Milton Keynes, 1987)

4. G. Pask, 'Styles and strategies of learning' B. J. Ed. Psyc. 46: 12 - 25 (1976).

5. M.C. Wittrock, 'Students thought processes' in M.C. Wittrock (ed) Handbook of Research on Teaching (Macmillan, New York, 1986).

COMPUTERIZED UNIVERSITY: A SIXTEEN-YEAR CONTINUING SUCCESS

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ABSTRACT

Meeting the administrative and academic technological challenges of the '90s, the third largest private university in California combines innovation with solid academics.

ADMINISTRATION

Sixteen years ago the challenge of the information age, which dictates that traditional educational delivery systems do not necessarily meet all of society's needs, was met through a fully accredited, innovative, computer-based higher education concept in San Diego, California, USA. Today National University consists of ten campuses and over sixty learning centers throughout California, Nevada and Central America, and has the third largest independent university student enrollment in California. Using mainframe, mini and micro computers, an on-line interactive database has kept educational administration costs well below the national average. Through the computer system students may register and have their schedules modified by an academic admissions advisor at any time, search for library materials, program and conduct research.

In 1969 the founding president of National University, David Chigos, interviewed over 2,600 industry, government and education executives asking their views on higher education. The overwhelming majority disliked traditional enrollment restrictions, the two semester system, lack of convenient schedule change and lack of professors who had successful work experience and knew how to teach. Using these and other solid inputs Dr. Chigos received on November 22, 1971 the charter for an independent, non-profit university of the '90s.

Fully accredited, National University is organized into seven academic schools: Aerospace Studies, Arts and Sciences, Engineering and Computer Sciences, Education, Law, Management and Business, Psychology and Human Behavior. Over one hundred degree, elective emphasis, credential and certificate programs are offered.

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Several unique features set this university apart:

1) Centralized administration serves campuses and learning centers through a sophisticated telephone and mainframe system.

2) It provides educational opportunities for mature adults who for the most part are working professionals, taught by professors who themselves are active in their field. Through the world's most sophisticated on-line, single database computer system for an institution of higher education, tuition costs are kept low and all administrative tasks (over 250,000 transactions per day) easily can be handled from any university terminal. Students may enroll and plan an entire schedule on any business day of the year.

3) Each class lasts only one month, not five, and consists of two 4 1/2 evening meetings each week, with a couple of all-day sessions on Saturday (48 hours undergraduate and 40 hours graduate work for a total of 5 quarter units). At the rate of one class per month, planned to blend with the schedules of full-time working adults, it is possible in many instances to complete a master's degree program within 12 to 15 months.

4) Walls in the form of traditional offices and secretaries do not exist. Each university staff member enters his or her own data directly into the computer system. This allows dynamic interaction between all levels of faculty, staff and students--any administrative changes are noted instantaneously throughout the university system.

5) With this computerized infrastructure, all that National University officials need to implement a new campus or learning center is an office and a telephone line. What would normally take a traditional educational institution years of planning and development can be achieved electronically in a matter of weeks.

ACADEMICS

Following are the Computer Science and Information Systems degree programs offered at National University's North County Campus:

1) For executives and middle managers
    a) MBA in Executive Computer Management
    b) BBA with emphasis in Computers and Business
2) For DP/MIS management
    a) MBA with emphasis in Computer Information Systems

    - b) BBA with emphasis in Computer Information Systems
    - c) BS in Computer Sciences (BSCS) - emphasis on the design of systems, especially compilers, operating, databases, and programming languages
- 3) For software development professionals
    - a) MS in Software Engineering (MSSE) - using the advanced application language Ada
    - b) BS in Computer Science

Several innovations solidly support the above programs including an advisory board consisting of top professionals in the fields of computer science and information systems, who have no ties to the university. Quarterly meetings are held and the board's findings are implemented.

Active membership in professional organizations is another source of valuable input enhancing academic quality. In addition strong ties with business and other universities permit technology of the '90s to be used and shared.

Student evaluation of professors is an integral part of maintaining academic excellence. Professors welcome the opportunity to receive feedback from each class.

Academic computer facilities consist of micro computers, UNIX and terminal laboratories. In addition NCR Corporation has installed a state of the art workstation laboratory in an Ethernet LAN connected to an NCR Tower mini. This in turn is connected to over 350 Tower minis, an NCR 9800 mainframe and other universities. These latter facilities permit extensive research. Computer laboratories open seven days a week permit students to work with equipment as necessary. In addition students in the MSSE program may access computers from their home.

BSCS students' core curriculum consists of fifteen courses which culminate in a three-month original senior student project. Students are encouraged to work with businesses on real world programs. MSSE students complete an original research thesis. In addition to the traditional documentation which is put in the university library, a document retrieval system has been developed on the NCR Tower allowing faculty and students to gain from the experience of previous classes.

Academic success is mainly due to the superb quality of faculty and students. Technology is a tool used to enhance the learning environment; people make the university!

MICROWORLDS - REALITIES NOT MYTHS

Robert K. Munro

ABSTRACT

Recent technological enhancement of microcomputer systems coupled with increasing sophistication of business-oriented, content-free software now offers education tools which generate information-rich, visually-oriented environments or microworlds which children can explore and manipulate.

The SCET funded Thorn Project used Macintosh computer hardware and advanced commercial visual database software to create the microworld of a fictional, yet extremely realistically modelled, town. Within this comprehensive information store, which could accomodate any socio-political or environmental issue at any level of sophistication, was embedded a particularly pertinent development issue. Explorers of this microworld discover the issue and, through further investigation, group discussion and other off-computer research, formulate solutions to the problem.

This paper explains the educational rationale underpinning the Project and argues for the widespread development of visual database software so that education can realize the potential of microworlds envisaged by Papert many years ago.

THE THORN PROJECT

Funded by the Scottish Council for Educational Technology and given staffing time support by the Consultative Committee for the Curriculum, the Thorn Project was carried out in Thorn Primary school in Johnstone. The central aim of this project was that education should employ leading-edge technology and state of the art software to create educational environments which allow users to participate fully in, and exploit the potential offered by, the information revolution. The computer was to be utilized as a tool for developing problem awareness, exploring hypotheses and facilitating problem solving within the framework of a "topic approach", which is an important component of educational and training activity.

The topic approach, deploying an appropriately selected diverse yet full range of resources to support an integrated set of activities, stimulates research skills, develops discussion and analysis skills and promotes genuine problem solving. The computer was seen as a critically important resource which could support and enhance these skills, facilitate the investigation of complex simulations, model scenarios, develop design skills, permit access to and extend analysis of huge information stores and promote improved communication skills.

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Using an Apple Macintosh computer with the innovative commercial software packages "Filevision" and "Business Filevision" the focus of the Thorn Project has been concerned with a very specific computer context, that of the storage and representation appropriate to a fictional community, a hypothetical yet very realistically conceived town. Users of the resultant courseware are introduced to and become involved with this community and explore a range of issues pertinent to the town. Their investigation and understanding of these issues is closely related to their acquired knowledge of the town and its internal and external relationships and functionings which they obtain through interaction with the computer held database.

The town´s regional location is important and the socio-economic characteristics of the town may be compared with other settlements in the region. Internally the town exhibits a variety of different urban areas with contrasting land use patterns, employment opportunity and structure, social characteristics and architectural styles. The hierarchically-structured database is extremely flexible and the user can move sideways at any level to permit e.g. comparison of different towns or industrial areas within the same town. The user can also move up and down the levels to home in on any part of the town or to pursue investigation right down to the level of individual firms, individual buildings such as houses and indeed individual people within these houses.

At each level the sophisticated and extremely user-friendly software enabled the Project Co-ordinators (with no programming expertise) to create any environments they desired. These were often of considerable graphical complexity but every element within every environment could, if required, link to associated interrogable data. Not all of this is hard statistical, factual data. Indeed it was considered important that much of the information should be ´interesting background´ or ´snippets´ through which users could browse. Thus an extremely comprehensive visual database has been created which permits users to explore the full range of socio-economic characteristics and issues which might be found in any community.

Increasingly, as the courseware was developed, we perceived that we could produce not just a complex and comprehensive database but that we could, by injecting the appropriate information, create opportunities for users to identify contentious issues and we could pose problems which we could require the software users to explore, discuss and attempt to resolve. Depending on the target user we could tailor the issue or problem appropriately by presenting either more or less information or by simplifying or making more complex the information base. User responses to the solution of the problems or issues could involve the use of the computer to interrogate on-line databases, to create design briefs and plans and compose reports.

The first development issue which we embedded in the database was related to population growth and associated urban expansion in one area of the town. Not only did the expansion encroach upon prime agricultural and leisure activity land it also created pressure on educational resources and necessitated the construction of a new school. There were three locations where the local council could build the school but, as in real life, all of these locations had advantages and disadvantages. Investigation of the files and back issues of the local newspaper at the newspaper office, perusal of the local council computer files, study of the correspondence held in the headmaster´s office and analysis of the site maps and planning documents at the architectural services department provided the students with a full range of detailed information. This enabled them to justify the selection of a site, choose a building style appropriate to the site constraints and plan in detail the internal and external facilities of the school.

Other topics which were considered for development included - ´Factory Closure´, ´The Out-of-town Superstore´, ´By-pass´, ´The Problem of Old People´, ´Strike´, ´Gas Explosion´ and ´Leisure Complex to be National Focus´. The concept of a large urban growth point lends itself so readily to the exploration of almost any societal issue.

THE POTENTIAL OF THE VISUAL DATABASE

The resultant courseware transcends the exceptionally sophisticated software and possesses tremendous educational potential. It is infinitely adaptable and can be used, not just at primary school level, but in secondary school, at college and university and in commercial and industrial training environments. Not only can the level of applicability be appositely tailored, the applications do not have to be subject specific. The software offers a generic template which can facilitate the creation of problem-posing environments replete with various contentious issues.

The potential to model, very realistically, any environment or scenario surely means that education now has a tool which educators, or students themselves, can use to create educationally-rich microworlds which people of all ages and backgrounds can explore. While the original school planning issue stimulated the inquiring minds of primary school pupils it would provide a fascinating problem for education officers, advisers and inspectors to solve.

THE WAY FORWARD

Since the Thorn Project concluded in June 1987 Apple has produced Hypercard software for use with the Macintosh. This excellent product incorporates many of the facilities originally conceived for Filevision. With Hypercard bundled with new Macintosh computers the tools for the simple creation of complex microworlds are available free of charge.

We hope that all manufacturers of advanced computer systems will recognise the value of visual database software and commission the development of similar software for their respective systems. Educators then, no matter their system preference, will have a resource they can use to create educationally rich and pertinent environments which will advance the teaching and learning process at all levels. In addition we would hope that the political decision makers in education seriously consider the formation of courseware development teams to create a range of educational resources from this sophisticated software.

The production of microcomputers of considerable sophistication with high capacity memory, excellent screen resolution and graphical input-output facilities, the advance of video and compact disc technology, the development of a comprehensive range of peripheral devices, complex simulation software , expert systems, parallel processing and alternative language implementations coupled with the increasing availability of access to burgeoning information sources of global dimension have thrust the technological revolution into a higher gear. The Thorn Project has made a contribution to the effective deployment of this fast developing educational facility. Without the fullest appraisal of the developing technological opportunity, far sighted forward planning, innovative thinking and a dynamic approach which receptively embraces technological integration education will become increasingly divorced from the benefits of the information revolution.

THE IMPLEMENTATION OF A FORMAL WRITING PROGRAM IN A FIFTH GRADE CLASS IN ORDER TO IMPROVE THE WRITING SCORES ON THE NEW YORK STATE FIFTH GRADE WRITING TEST

Evelyn Rothstein, Ed.D.

ABSTRACT

This report describes the implementation of a structured writing program in class 5-2 at Community Elementary School 73 in the Southwest Bronx. Scores on the spring 1984 and 1985 New York State Fifth Grade Writing Tests and current fifth grade student writing samples indicated the need to improve the writing competencies of students.

Teaching Writing: A Developmental, Systematic Approach by Evelyn Rothstein was the methodology used to improve the writing competencies of students in class 5-2. Through the structured writing program, students were taught specific writing strategies: sentence expansion, substitution, combining and embedding, paragraph structure, and organizational patterns. Students integrated these strategies in all areas of the curriculum. Student compositions were scored holistically using the Criteria for Rating Student Responses. Students improved their writing skills in a minimum of three out of five areas on the New York State Writing Product Analysis Sheet and made significant progress on the New York State Fifth Grade Writing Test.

IDENTIFICATION BACKGROUND AND EVIDENCE OF THE PROBLEM

There was a definite need to improve the writing skills of the fifth grade students in School District Nine in the Bronx and the writing skills of the students at Community Elementary School 73 in particular. The need became evident as the writer carefully examined students' reports, compositions, daily assignments and trends of writing achievement over the past two years as measured by the New York State Fifth Grade Writing Test.

According to the New York State Education Department's Writing Manual for Administrators and Teachers, the purpose for the test is to measure how well a student can write and to apply the results in the following way:

(1) Evaluating a student's current level of achievement in writing;
(2) Determining trends in students' ability to write;
(3) Indicating the extent of compensatory or remedial help, if any, that a student may need.
(4) Providing a basis for termination of remediation.

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DETAILED DOCUMENTATION

In order to understand the statistical analysis of the New York State Fifth Grade Writing Test, one must first explain the components of the test and how it is scored. Students must demonstrate their ability to write two different types of prose on a two-part test. One piece of writing is experiential in nature and the other creative. While the test is untimed, it is suggested that the test be administered over a two-day period and each part takes approximately 90 minutes to complete. Students are told to go through various stages of the writing process: pre-writing, drafting, revising and editing and the directions given by the teacher and test encourage them to do so.

The test is scored holistically. This means that the writing is judged on its overall merit rather than individual errors. The New York State criteria for rating students' responses holistically is based on a four (4) point system, one (1) being the lowest level of response and four (4) the highest. A student can score a zero (0) if the written piece is indecipherable and does not address the topic.

Since holistic scoring is subjective in nature, two people are required to rate a piece of writing. If there is a discrepancy in the scoring, a third and independent rater is to read the piece in order to resolve the situation. The two contiguous scores remain.

The highest score that can be obtained on the Fifth Grade Writing Test is 16. A student could conceivably receive an 8 on both the first and second parts of the test. Therefore, he/she would receive a total of 16.

PROBABLE CAUSES OF THE PROBLEM

Until the implementation of this program, there had been no formal structured writing program and no teacher had been trained to teach writing and the writing process. There was no prescribed scope and sequence of writing skills and tasks, so teachers were on their own to teach writing as they saw fit.

In this study, students were placed in a program called Teaching Writing A Developmental Systematic Approach by Evelyn Rothstein which emphasized the writing process. This program provided the teacher with specific writing strategies to enhance students' writing skills.

This particular methodolgy was selected because of its strategies and structure. The strategies are easily learned and developed with the appropriate instruction, practice and reinforcement. Teachers who have had little or no formal training in the teaching of writing can easily follow the strategies outlined in the Teacher's Manual.

Rothstein begins with the concept that writing can be made more interesting and that it can be improved by adding, deleting, substituting, and rearranging words. Strategies are presented in the following way:

1. *Sentence sense and sentence composing*
2. *Sentence expansion*
3. *Substitution*
4. *Moving and Rearranging*
5. *Combining and embedding*
6. *Paragraph structure*
7. *Plans, blueprints, and outlines for full-length compositions*

EVALUATION

The implementation of Teaching Writing A Developmental, Systematic Approach at Community Elementary School 73 had a positive effect on the scores of the New York State Fifth Grade Writing Test.

Table Six shows the results of Class 5-2's performance on the spring 1986 New York State Fifth Grade Writing Test. Column one indicates the score. The writing test is scored on a scale of 0-16. Column two indicates the frequency or number of students receiving a specific score. For example, only two students scored six and five studens scored nine. The third column tells the percentage of students achieving a particular score. The last column determines the average percent of the mean. Note that 85.15 percent of the students in the target class scored above the state reference point and only 14.80 percent scored below. These scores are significantly higher than the three other classes.

Table 6

COMPARISON TO STATE REFERENCE POINT/FREQUENCY DISTRIBUTION

BY CLASS 5-2 - COMMUNITY ELEMENTARY SCHOOL 73 - SPRING 1986

Below State Reference Point				At and Above the State Reference Point			
Score	Frequency	Percent	Frequency X Percent	Score	Frequency	Percent	Frequency X Percent
00	0	.00%	.00%	08	6	22.22%	133.32%
01	0	.00%	.00%	09	5	18.51%	92.55%
02	0	.00%	.00%	10	5	18.51%	92.55%
03	0	.00%	.00%	11	1	3.70%	3.70%
04	0	.00%	.00%	12	3	11.11%	33.33%
05	1	3.70%	3.70%	13	1	3.70%	3.70%
06	2	7.40%	14.80%	14	2	7.40%	14.80%
07	1	3.70%	3.70%	15	0	.00%	.00%
				16	0	.00%	.00%
TOTAL	4	14.80%	22.20%		23	85.15%	373.95%
Average Percent of the Mean			5.55%	**Average Percent of the Mean**			16.26%

EVALUATION OF TERMINAL OBJECTIVES

The writer identified three terminal objectives and two out of three were fully achieved, with the third objective partially achieved.

As a result of using specific writing instructional materials and strategies during the period January 1986 to June 1986, the students in class 5-2 demonstrated an improvement in writing skills by reducing by 1.5 percent, the average of the mean, the number of students falling below the state reference point in 1986 as compared to the spring 1984 and spring 1985 New York State Fifth Grade Writing Test.

The writer had predicted that students would improve their writing skills by reducing the average percent of the mean of students falling below the state reference point by 1.5 percent. That figure was reduced by 3.47 percent. A smaller percentage of students fell below the state reference point in class 5-2 on the spring 1986 New York State Fifth Grade Writing Test as compared to the spring 1985 test. The objective was achieved.

A second objective was also met: the students of class 5-2 also demonstrated an improvement in writing skills by increasing the average of the mean by 3.4 percent above the state reference point in 1986 as compared to the results of the spring 1984 and spring 1985 New York State Fifth Grade Writing Test. An examination of table 6 clearly shows that class 5-2 made significant gains when compared to the other fifth grade classes.

The writer had also projected that as a result of regularly monitoring specific writing strategies during the period January 1986 to June 1986, 60 percent of the students in class 5-2 would demonstrate sequential development of writing skills in three out of five skill areas as measured by the New York State Writing Project Analysis Sheet (WPAS). The five areas measured on the (WPAS) were: Task/Content, Organization, Sentence Structure, Language, and Mechanics. Eighty five percent (85.18%) of the students improved by achieving at least one increment of growth in three out of five areas. Most students improved in the area of organization. The writer believes that this was due to the emphasis placed on the three organizational strategies: the framed paragraph, three reasons why, and the definition model.

RECOMMENDATIONS AND CONCLUSIONS

It is recommended that the program Teaching Writing: A Developmental, Systematic Approach *be implemented in grades three, four and five. The writer believes that third and fourth grade students who will have had the advantage of two and three years of formalized writing instruction, will view writing as a craft and develop a more sophisticated style of narrative and expository types of writing.*

THE COGNITIVE ADVANCEMENT OF THE CHILD-COMPUTER DYAD

Frank B. Murray*

We know--from several independent lines of research--that when pupils work cooperatively with their peers on an academic task, there is invariably greater academic growth than there would have been had the pupils worked alone on the same task. When the academic task is a developmental task as well as an academic task, that is when the task has a strong relationship with age, particularly mental age, we know that the sufficient condition for the young pupil's success may be little more than the opportunity for the child to interact with another child who has an opposing and maturer point of view about the way to solve the task.

Developmental tasks are, for the most part, domain specific and the child's solution of the task does not extend easily to other versions or modifications of the task, let alone to other domains of related tasks. That these tasks are constructed piece by piece over various materials and contexts has led several researchers to suppose that cognitive development could be facilitated were the child to explore the domain in question in a microworld of a computer--a world in which the regularities of the child's interactions with the environment are simulated with a computer. The notion is that the formalisms and laws that the child eventually comes to construct will develop sooner and more cleanly through the child's interaction with a computer. Even if the computer simulation is a poor model of the domain in question and even if, as a result, there is little positive transfer between the child's proficiency with the computer tasks and their real world counterparts, the child's proficiency with the computer could entail the very same logical operations that define, for example, the Piagetian operational stages.

However, there is another way, often neglected, in which the computer can be supposed to influence cognitive development. Rather than simulate the interactions of the children with their environments in certain domains, the machine might simulate their interactions with other children, particularly children who are at a somewhat more advanced cognitive level than they are. These interactions, these cooperative and collaborative events, have been theoretically and empirically established as necessary--and sometimes as sufficient--conditions for intellectual development.

THE CHILD-COMPUTER DYAD

There is no reason to think that the cooperative learning research findings will fail to hold when the instructional task is computer-assisted, and in fact all the cooperative learning outcomes are found when children work together to solve instructional problems set for them by a computer. However, the literature on child-child dyads suggests that the computer need only present the opposing and correct point of view to the child--and then only contingently and for relatively brief periods of genuine dialectic. Can machines pass as peers, so to speak, in a situation like the child-child dyad in domains as narrow as the Genevan operativity tasks? In limited domains of knowledge, and if the interrogation is gentle, any number of programs may now meet this test.

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The proposal to simulate a peer for the child in the child-computer dyad calls for the creation of a combination of the expert advisor and surrogate instructor features of artificial intelligence systems that would and could enter into a "dialogue" with the child. When the domains are narrow, as they are for the concrete operational tasks for instance, the development of intelligent computer-assisted instruction (ICAI) is feasible. Such a system amounts to the programming of the epistemic subject and would be based, presumably but not necessarily, on the appropriate operativity structures. Whether the machine would ever pass Turing's test and pass for a child is an empirical question, but one about which there could be some optimism given the child's animistic proclivity. The lessons from the child-child dyad research are clear in showing that the effectiveness of the message is not easily separated from the medium, in that instance another child. The same information, presented in other formats--especially non-social formats--is only marginally effective in promoting genuine cognitive development.

THE NON-SOCIAL CHILD-COMPUTER DYAD

Apart from the microworld function in the child-computer relationship, in which the child explores and manipulates a rule-governed universe that serves as an analogue for some significant aspects of the "real" world, the computer may provide a more direct tool for the child to use in the discovery and invention of principles in his immediate environment. The computer itself can be a tool, like note-taking or measuring, in the service of the child's exploration; in other words, it can be an amplifier of cognition--a device for increasing the amount of cognitive workspace the child can bring to bear on a problem by shifting significant portions of the information-processing load from the mind to the machine. One potent consequence of this shift is that aspects of the mind are made available for external examination, inspection, and reflection in much the same fashion as language and logic provide a device for thinking about and enhancing thought itself. There is no question that the child's performance on any number of developmental cognitive tasks can be improved when the task is presented in a format and context that minimize the amount of processing that must take place inside the mind, so to speak. It is doubtful that these simplified tasks, despite the child's flawless performance on them, have anything to do with operativity or the child's appreciation of the necessity of his correct response. Nevertheless, the task can be made easier and solvable if the child's expanding, but frail information processing, can be circumvented by a computerized representation of some of the problem's critical variables and their relationships. The issue is whether the child's successful performance on the computerized version of the operativity task is still a theoretically valid indicator of a developmental change. While it may be true that children who were not formal operational thinkers could solve certain formal operational problems with the aid of a computer program, the question is, "How did they do it?" Did they just get the right answer or did they employ formal operations to the problem? If they did employ formal operations, then they were formal operational in the first place.

This issue is always clearest in cases where there is no processing overload, where the child has noted and remembered all the relevant factors and thus has all the information needed for solution but has no way, apparently, to convert this apprehension of all the relevant information into the required deduction that would be the correct operational answer to the problem. The child, in other words, had no way to convert what was merely true into what must be true. This conversion is the key developmental question.

THE CHILD-COMPUTER STAGE

In the end, the question of the centrality of computing in cognitive development will be one of discerning when a technology shifts from being a mere amplifier of the mind to a transformer of the mind. Will the habitual computer users eventually be in a new stage of mental functioning? Will they, with or without their computers, have a way of operating on problems that cannot be explained by the very same cognitive principles that were adequate to explain the workings of the "pre-computer mind?" What benefit does or could computing confer on a developing mind that would not be conferred, for example, by collaboration with a peer or by the child's confrontation with some other event?

The findings from the social interaction studies are clear--children confronted by a cognitively more advanced peer develop in the direction of that peer. However, recent work in the Vygotskian tradition in which a peer collaborates with or complements the child's point of view instead of challenging or confronting it has implications for the potential of the child-computer dyad to reach higher levels of cognitive functioning. It shows that the child-peer dyad performs the task at a higher level than the members can perform it alone, even after their successful collaboration on the problem. In other words, the dyad would be at a high cognitive stage, but its members would, on their own in the disbanded dyad, remain at a lower stage. Presumably this outcome would be the same for the child-computer dyad and indicates that the lower stage children would remain in the lower stage despite the fact that with their computer they gave evidence of higher stage accomplishments. We are left, of course, with the enduring question of what is developing in this dyad situation--the competence of the dyad or of the member, and which competence is of central concern?

THE IMPACT OF HIGH TOUCH IN THE HIGH TECH WORLD OF EDUCATION

R. Bollet and R. Cornell*

ABSTRACT

Increased attention is being paid the concept of "high touch" by educator and citizen alike. The root cause ascribed to a diversity of ailments which afflict many who find themselves surrounded by increasing amounts of technology can be traced to man's earliest attempts to communicate. Recognition of cause and efforts to alleviate resultant stress are available but, to be effective, individuals must not only understand the origins of the problem but, must then act upon it as well.

THE SETTING, PAST AND PRESENT

John Naisbitt (ref 1) said it best: "...whenever new technology is introduced into society, there must be a counter-balancing human response--that is, **high touch**--or the technology is rejected."

Alvin Toffler (ref 2) seconded Naisbitt's concern and added, "...any decent society must generate a feeling of community...Yet today the institutions on which community depends are crumbling in all the techno-societies. The result is a spreading plague of loneliness."

It has been primarily since the late ninteenth century, that the inclusion of Naisbitt's "new technologies" have been typecast as everything from "a passing fad" to "it'll never work, Orville!" And yet, if we take only a random sample of some of these technologies, we would find that they predate that fabled era of discovery by centuries and yet, each of them most likely was accompanied by no small amount of stress, frustration, angst, loneliness and yes, even hatred.

Looking to the distant past we can obtain some notion of how things were. Looking to the less distant past we can even further assess technology's impact. Looking at both the present and into the future (if such boldness may be permitted!) we can then draw inferences as to 1) the impact of technology through the ages and 2) technology's residue and some prescription to remedy the increasing number of technocracy maladies which are occurring.

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Distant Past: **Cave Dwellers:** Primative Cave Paintings, Spoken Word Emerged; **Ancient Egypt:** Hieroglyphics, Papyrus, **2nd Century:** Gunpowder, Paper, Ink **5th Century:** Blocks & Block Printing; **9th Century:** Hand-crafted books; **15th Century:** Gutenberg's Printing Press

Less Distant Past: **17th Century:** First Newspapers: **18th Century:** Magazines; **19th Century:** Marconi - Wireless, Bell - Telephone, Edison - Phonograph, etc.; **20th Century:** 1903- Orville & Wilber Wright's Flight; 1920's-Australian School of the air-Flying Doctor Service; 1925-Scopes "Monkey Trial"; 1926 Valentino Dies and Riots Ensue: 1929-Vatican City Radio Station; 1930-Goddard's First Rocket Flies; 1931-Marijuana and TV Debut; 1933-Assassination Attempt on Franklin Delano Roosevelt; 1937-Walt Disney's "Snow White" premiers; 1938-Benny Goodman at Carnegie Hall, Jitterbugs; 1943-Frank Sinatra Riots; 1945-TV Sets Mass Produced; 1955-Jonas Salk Polio Vaccine; 1957-Soviets Launch "Sputnik".

Present and Future: Teaching Machines-Programmed Learning; CCTV; Langauge Laboratories; Computers; Supersonic Jets; VCR's; Compact Discs; Laser Discs; Space Shuttle-Space Station; Undersea Communities; Mission to Mars, etc.

As the foregoing demonstrates, it has been the super-rapid advances of the technologies within the past 100 years that have tended to overwhelm, to bring on the era of the anxious participant, be that person a member of a family, a student within a school, or a member of a business. Let another, far more eloquent than we, state the case as to where we often now find ourselves:

> With the arrival of the electric technology, man extended, or set outside himself, a live model of the central nervous system itself. To the degree that this is so, it is a development that suggests a desperate and suicidal autoamputation, as if the central nervous system could no longer depend on the physical organs to be protective buffers against the slings and arrows of outrageous mechanism. It could well be that successive mechanizations of the various physical organs since the invention of printing have made too violent and superstimulated a social experience for the central nervous system to endure (ref 3).

Even a cursory examination of contemporary society reveals that, indeed, many of our central nervous systems are being asked to endure far more of McLuhan's "slings and arrows of mechanization." Cases in point:

Marvin Cetron, President of Forecasting International, an Arlington, Virginia-based firm states: "The personal computer business is growing so fast that I think there will soon be more computers than television sets in American households. We spent one billion dollars on all textbooks during the past two hundred years. We are going to spend one billion dollars before 1990 on computer-assisted education (ref 4)."

He also indicated that, by 2000, "twenty percent of the population will work at home...But when the husband and wife are both regularly working at home with computers, that's the time to look for a big increase in the divorce rate, maybe even a quadrupling of the present rate (Ibid)."

In an article relating to the spate of nuclear power plant mishaps, the lead sentence said it all: "**Technology was supposed to solve problems, not cause them.** To free mankind, not hurt the innocent. But in the span of a few months, the dark side of technology has asserted itself (ref 5)." That same article quoted Albert Einstein : 'The unleased power of the atom has changed everything save our modes of thinking, and we thus drift toward unparalleled catastrophes.' (Ibid).

The use of computers in planning marketing strategies, reveals that "a pitched battle has broken out pitting the behaviorists (who believe that the best indicator of how people will act in the future is how they act now) and the cognitists (who believe that people operate from an endless array of motivations and the only way to predict what someone will do is to figure out what is going on inside his or her mind). One group relies heavily on computer-based surveys while the second places its efforts in the one-on-one survey method. While one marketing expert insisted that"High tech will never replace high touch, others argue otherwise (ref 6)."

So here we find ourselves, facing a confrontation with the Automatic Teller Machine at our not-so-friendly bank; nodding off at the controls of a 747 on a transoceanic flight because of too much instrument monitoring fatigue; receiving a not-so-friendly note from Macy's or Harrods indicating that our "account is past due;" or any number of other technology-related traumas.

We suggest that technology's effects are extremely relevant to the ways society's problems need to be viewed and, furthermore, that as educators interested in prevention as well as change, we must bear a special ethical responsibility to consider ways to mediate the impact of these effects upon the individual.

Social ecology is an integral part of the human experience (ref 7) and, in a technological society, rapid shifts in that ecology can become the norm rather than the exception. Constant change in our social and physical ecologies may be a precondition of modern society, the direction however, of any given change is not. A technological world is a human creation, a world of choice rather than a determined world (ref 8).

People's attitudes about their world are changing with different expectations being held of a "technological" world than of one termed "natural." An example of this may be found in Baum et al (ref 9) which compares the effects of natural disaster as compared to a technological catastrophy. One by-product they found was more focused anger by technological disaster victims because, as opposed to a natural disaster, there is a person or agency upon which to place the blame.

In this regard, educators have an ethical mandate to participate in decisions that determine which technologies will be developed and how they will be applied. We look forward to expanding this discussion in Edinburgh.

REFERENCES

1. John Naisbitt, Megatrends (Warner Books, NY, 1982) p 367.
2. Alvin Toffler, The Third Wave (Morrow, NY, 1980) p 367.
3. Marshall McLuhan, Understanding Media: The Extensions of Man (McGraw-Hill, NY, 1964) p 43.
4. Marvin Cetron, "Interview Marvin Cetron" Omni, April, 1985, p 88.
5. William L. Chaze and Maureen Santini in Washington and Nicholas Daniloff in Moscow, "Living Dangerously" U.S. News and World Report, May 19, 1986, p 19.
6. Claudia H. Deutsch, "What Do People Want, Anyway?" The New York Times, November 8, 1987, p F4.
7. D. Hulse, "Overcoming the Social-ecological Barriers to Group Effectiveness: Present and Future" Journal for Specialists in Group Work, 10:85, pp 92-97.
8. B. Murchland, "Citizenship in a Technological Society: Problems and Possibilities" Journal of Teacher Education,34, pp 21-24.
9. A. Baum, R. Fleming and L.M. Davidson, "Natural Disaster and Technological Catastrophy" Environment and Behavior,15, pp 333-354.

USING PROLOG AND EXPERT SYSTEMS ENVIRONMENTS TO ENHANCE DECLARATIVE AND PROCEDURAL KNOWLEDGE IN ELEMENTARY SCIENCE INSTRUCTION

Michael R. Vitale*, Nancy Romance*.

ABSTRACT

This paper overviews the preliminary status of a project in which undergraduate preservice elementary education teachers will learn to use open-ended microcomputer-based artificial intelligence environments (PROLOG, expert systems) as tools to enhance their acquisition and subsequent teaching of declarative (content) and procedural (applications) forms of science knowledge. In doing so, design requirements and associated strategies leading toward the development of a comprehensive knowledge-based set of science activities for elementary classrooms are discussed.

INTRODUCTION

Improvement of science instruction in elementary schools is well recognized as an important educational priority (Linn, 1987). Although this problem reflects many historical factors, there is evidence that PROLOG and expert systems shells offer a unique set of student learning tools that support the qualitative improvement of elementary science curriculum, classroom instructional practices, and teacher preparation programs. With this in mind, successful demonstrations using PROLOG-based expansion activities in elementary science and other curriculum areas with students as young age 10 have been reported by Ennals (1986, 1984), Ennals & Briggs (1985), and Scherzas et al (1986). In confirming the feasibility of PROLOG-based classroom activities being used by elementary teachers and students, these studies have given rise to the subsequent educational engineering issues pertaining to a more comprehensive use of such tool environments across the science curriculum at the upper elementary levels and the associated teacher preparation requirements.

PROLOG AND EXPERT SYSTEMS TASKS IN SCIENCE INSTRUCTION

The immediate focus of this project is to train undergraduate elementary education teachers to use open-ended microcomputer- based artificial intelligence environments (PROLOG, expert systems) as tools to enhance their acquisition and subsequent teaching of declarative (content) and procedural (applications) forms of science knowledge. The relevance of PROLOG and simple expert systems to the problem of improving science instruction is best understood through the concept of a logic-based operational model as a form of theory construction advanced by Reynolds (1971). In an research example, Roach & Fuller (1986) showed the usefulness of representing a social process theory as a PROLOG-based computer program whose implications were testable. In a complementary notion, Willson (1987) has pointed out the value of meaningful "theory-building" activities in science instruction for novices having minimal domain-specific knowledge as a strategy for simulating the knowledge acquisition process of scientists.

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PROLOG is an artificial intelligence programming language designed for symbol manipulation rather than numeric computation that emphasizes declarative program design. Thus, PROLOG easily supports the interplay of information structures and the application of logical rules within simple deductive systems. One simple example of such logic programming activities in elementary science instruction would be representing stages and major causal factors of the water cycle as a PROLOG program and then querying the system for implications as different causal conditions are modified. From a general perspective, the PROLOG working environment can be considered an inferential knowledge-base consisting of sets of object-facts, concept definitions, and science principles represented as concept relationships.

Expert system shells are software environments designed to support capturing knowledge in the form of IF/THEN production rules and then to guide individuals through an objective problem-solving process using the knowledge-based rule system. Analogous to using a word processor to construct a document, building a simple expert system involves a mix of structured knowledge utilization and identification of decision rules operable within the application of a knowledge-domain, followed by subsequent modification or editing of the system as it evolves. One simple application of an expert system shell in elementary science instruction would be to use weather principles to construct a simple weather predictor that would assist with the interpretation of newspaper weather maps.

Considered together, PROLOG and expert system shells provide unique knowledge-based learning tools through which preservice teachers (and eventually their elementary students) can gain increased science understanding by constructing logical models to explore and apply abstract knowledge and concept relationships.

ENGINEERING REQUIREMENTS FOR CURRICULUM APPLICATIONS

In a recent analysis of computer-based microworlds, Thompson (1987) recognized the importance of curriculum-based problem sets in providing an underlying curriculum focus to what otherwise would be undirected exploration activities. The comprehensive use of PROLOG-based environments across an elementary science curriculum must realistically address this concern through the following issues:

(1) Knowledge-based classroom expansion activities must be time-scaled within and comprehensively keyed to the existing science curriculum,

(2) Problem sets composing the activities must be consistent with technical principles of learning and instruction and appropriate to educational developmental levels,

(3) Use of the science knowledge base underlying activities must be coordinated with a parsimonious set of required logic programming and expert systems practices,

(4) Core training programs for teachers use of and instruction upon the problem activities must be designed carefully and validated empirically,

(5) Measurable "value-added" learning outcomes associated with the use of the expansion activities by teachers and students must be specified and assessed rigorously.

When the requirements above which lead to a comprehensive set knowledge-based science activities are contrasted with the more limited demonstrational research reported in the literature, it is clear that significant long-term methodological and developmental work remains to be undertaken.

DEVELOPMENT STRATEGIES FOR COMPREHENSIVE SCIENCE ACTIVITIES

The developmental research strategies adopted are as follows:

(1) Existing studies illustrating that students aged 10 and older can use PROLOG programming activities in classroom settings are accepted,

(2) Prospective teachers in teacher preparation courses serve as an initial focus for developing and validating training systems for using both PROLOG and expert systems application skills in elementary science instruction,

(3) A comprehensive curriculum analysis and semantic representation of science content taught in grades 4-6 is undertaken in order to establish a foundation for a comprehensive series of problem sets using PROLOG and expert systems,

(4) Assessment criteria based upon the role of the problem sets with supporting evaluative research designs are used to establish the instructional "value added" in terms of student learning and the facilitation of teacher effectiveness in science instruction.

Although in a preliminary phase, the present project has begun to implement the preceding strategies by initiating a curriculum analysis of science textbooks in grade 4, completing a number of small PROLOG and expert systems prototype applications in the area of weather principles and predictions, completing the initial design for a pilot training program for preservice elementary teachers, adopting direct instruction teaching methodology as a core theory for PROLOG and expert systems student classroom activities, and establishing the preliminary design of evaluative research study exploring the effect of expansion activities in the area of weather principles.

REFERENCES

Ennals, R. Beginning micro-PROLOG. London: Ellis Horwood, 1984.

Ennals, R. & Briggs, J. Fifth-generation computing: Introducing micro-PROLOG into the classroom. Journal of Educational Computing Research, 1, 1985, 97-111.

Ennals, R. Teaching logic as a computer language in schools. In M. Van Caneghem & D.H.D. Warren (Eds.), Logic Programming and It's Applications. Norwood, N.J.: Ablex Publishing, 1986, 129-144.

Linn, M.C. Establishing a research base for science education: Challenges, trends, and recommendations. Journal of Research in Science Teaching, 24, 1987, 191-216.

Reynolds, P.D. A Primer of Theory Construction. Indianapolis: Bobbs Merrill, 1971.

Roach, J.W. & Fuller, T.D. A PROLOG simulation of migration decision-making in a less developed country. In M. Van Caneghem & D. H. D. Warren (Eds.) Logic Programming and It's Applications. Norwood, N.J.: Ablex Publishing, 1986, 152-160.

Scherz, S., Maler, O., & Shapiro, E. Learning with PROLOG- A new approach. Journal of Computers in Mathematics and Science Teaching, 1986, 6, 31-37.

Thompson, P.W. Mathematical microworlds and intelligent computer-assisted instruction. In G. Kearsley (Ed.) Artificial Intelligence and Instruction: Applications and Methods. Reading, Mass.: Addison-Wesley, 1987, 83-109.

Willson, V.L. Theory-building and theory-confirming observation in science and science education. Journal of Research in Science Teaching, 24, 1987, 279-284.

TECHNOLOGY IN VOCATIONAL EDUCATION

C. Everette Bradley*

ABSTRACT

Approximately two-thirds of the 1,600 students enrolled in Lee County Senior High School are enrolled in vocational education. The businesses and industries which employ the vocational graduates have rapidly adapted technical innovations. In order to prepare students for the modern work environment (or to pursue advanced training), the Lee County vocational program provides computers for word processing by secretarial students, instruction in computer applications for a variety of students, automated spread sheet applications for accounting students, national data base support for business students, computerized diagnosis for auto mechanics students. The latest technology available for manufacturing students links the output of computer drafting and design (Auto Cad) with automated control of turning and milling operations in the machine shop.

In addition to the use of technology in instruction, computers and scanners are used to track student performance on tests. Another program is used to match student's aptitudes with available occupations.

INTRODUCTION

Lee County has a population of 42,500 and enjoys a variety of businesses and industries. There are 7,500 students enrolled in our public schools in grades K-12. Central Carolina Community College in Lee County has an enrollment of 2,200 full time equivalent students. This paper will focus on technology in vocational education in grades 10-12 in the public school system. Technology is used to prepare our young people to enter employment upon graduation or preparation for advanced training beyond high school.

Lee County Senior High School serves all students in Lee County in grades 10-12 with an enrollment of 1,600. The high school is a comprehensive school offering a wide range of instruction designed to serve the needs of all our youth. Vocational education is one area designed primarily with two purposes. The first purpose is to train our youth to enter employment while the second purpose is to prepare them to move into more advanced training at the postsecondary level. Historically one-third of the graduates go on to a university, one-third go to a community college and one-third go directly into full-time employment after graduation. The one-third (167) entering employment plus the one-third (167) choosing advanced training or a total of 334 graduates annually could profit from some vocational training. The school in fact, has two-thirds (1,000 students) of the students enrolled in vocational education.

Technology continues to explode in businesses and industries in our county, state and nation. Technology in vocational education is therefore an absolute necessity or we graduate youth unprepared for the age in which we live. High technology, only a few years ago, was the exception but at present it is the rule in businesses and industries. The school has responded to this situation by providing 100 Tandy computers for vocational education.

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OUTLINE OF TECHNOLOGY IN VOCATIONAL EDUCATION

Whether on a free standing word processor or a computer, word processing skills are required by almost every office in our community. Secretarial students are taught word processing fifty percent of the time in advanced courses while the remaining time involves training on the electronic typewriter.

Manual accounting is rapidly disappearing, hence, the need to develop skills in computerized accounting. Accounting problems can be completed rapidly and accurately with the computer preparing students for the modern work environment.

Two rooms are equipped with twenty-five computers each for instruction in Computer Application. This beginning course contains instruction in word processing (9 weeks), spread sheet (9 weeks), data base (9 weeks), and accounting (9 weeks). This is a very popular course with 250 students enrolled.

A subscription has been purchased from Dow Jones News Retrieval Service (a telecommunication service) providing the business program access to forty-four data bases. The business students, through telecommunication, have instant access to stock market information and a host of additional data pertaining to the business world.

Mechanics are rapidly being required to learn about computers in their trade. The mechanic student is trained to use computerized automotive test equipment. This area is so complex that it is developing into a field in itself.

Computer controlled equipment is used in many different ways in manufacturing. It is used in drafting and design, robotics, and computer controlled machinery to name a few. The school has chosen Computer Assisted Drafting (CAD) and computer controlled machinery as the means to teach the concepts and principles of Computer Assisted Manufacturing (CAM). A Computer Assisted Manufacturing Advisory Committee has been formed from local industry to guide and advise us in our efforts. These twelve members represent a variety of industries and each is a highly trained technical person.

In the drafting and design program students begin by developing their skills and learning the principles and concepts with drafting hand tools. From the manual skills they advance into Computer Assisted Drafting. In a drafting room designed for a maximum of twenty students, we have five work stations for students to develop drafting skills using the computer. The tablet, mouse, printers and plotters are provided for their training. The software chosen for use is Auto Cad since this is most often used in our county by the community college and industries. Students are trained in the design of metal parts to be manufactured as well as architectural design.

After the drawing has been generated in the CAD system, CNC software extracts the drawing from the CAD system and generates the geometry that is transformed into a machining code that the machine understands. Master Cam is the software we have chosen for this purpose. The computer transmits the machine code to the turning and milling machines which in turn manufactures the item. The lathe, which is the Dyna Myte 3000, has a computer which uses the machine codes to control the movement of the cutting tool to make the designed item. In like manner the mill, which is the Dyna Myte 2400, has an integral computer to control the cutting tool to make the cuts to produce a part which was designed in the drafting program using the Auto Cad software.

Technology is applied in the test scoring of daily student tests. A scanner is used to read student responses while the computer grades the test providing instant feedback and stores the data for future use. Student aptitudes are assessed by using a card scanner and a computer. This assessment includes twelve areas and after being read into the computer, the student is given a hard copy of the occupations one may expect to be able to do, training required, names of schools providing training, and names of employers in this area employing such people.

CONCLUSION

The Lee County Senior High School Vocational Program is fortunate to enjoy a solid base of support from management of a variety of light manufacturing industries and service businesses. Interaction with highly trained technical personnel has provided a major impetus for improving most vocational offerings through the integration of up-to-date technology.

In a constantly changing environment, it is neither simple nor inexpensive to improve programs so that students can be trained for the equipment and techniques they will encounter upon entrance into the work force. The only alternative to improvement, however, is to train today's students for yesterday's jobs.

EDUCATIONAL REQUIREMENTS FOR SOFTWARE PORTABILITY

Alistair J Fyfe*

ABSTRACT

Since 1980 a great deal of money has been invested in the development of computer software for use in schools in the UK but much of this has been targetted at one specific machine. Schools which have different types of microcomputer cannot, with a few notable exceptions, take advantage of this investment. Now there is a greater emphasis on the production of curriculum packages based on content free educational software tools which are even more expensive to develop. It is, therefore, increasingly important that educational programs run on as wide a range of microcomputers as possible and this can only be achieved if there is a more standardised approach to the purchase of hardware and the development of software. There will be other advantages to be gained from this approach as the paper argues.

INTRODUCTION

In many ways the use of computers in schools can be said to be still in its infancy, although there have been very significant changes in many aspects of this field over the last decade. In Scotland 10 years ago schools and authorities were still struggling to implement the ideas outlined in the Bellis report (ref 1) which was published in 1971. This advocated the introduction of a non-examinable computer appreciation course for all pupils in Scottish secondary schools, the promotion of the use of the computer as a tool for the teacher and argued strongly against the introduction of computing as a subject in its own right. A small number of authorities had purchased minicomputers which were shared between groups of schools but the vast majority of establishments had to make use of batch processing facilities in about 6 colleges and teachers centres around the country.

By the start of 1983 virtually all secondary schools had at least one microcomputer and some had several. The programme of introduction to primary schools was just beginning and there was great debate about which of the options offered by the Department of Trade and Industry was the most appropriate. At that time the emphasis was clearly on programs of the drill and practice type. The development of systems like the BBC micro with its impressive colour graphics facility made it possible to produce very attractive programs of this type. Technically they were comparatively unsophisticated, written mostly in BASIC, and sufficiently small that 10 or 12 programs covering a number of different topics could be distributed together on a single tape or disc.

EDUCATIONAL SOFTWARE TODAY

The last five years have seen the development of different types of software. A wide range of packages of the simulation type have been produced for many stages of the school and many aspects of the curriculum. Increasingly these programs have become more comprehensive, both in terms of the computer software developed and the additional material produced to accompany them. Considerable amounts of time are devoted to the production of modern packages by programmers working with teachers.

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Today, the emphasis is on making available to teachers the packages which may include computer programs, teachers notes, pupil work-cards and other material which teachers can adapt to meet their own needs. Increasing use is being made of "generic" programs such as word processors, databases and spreadsheets, and other programs reflect the need of teachers to be able to add alternative data or to control certain aspects of the way in which programs can be used.

The acceptance by teachers of these new packages is a most encouraging sign. In the past it has been accepted by many people that teachers wish software that can be used with the minimum of preparation and the minimum of technical expertise on their part. Now many teachers are clearly indicating that they are prepared to devote more preparation time to the integration of the microcomputer into the work of the classroom. Many authorities have already recognised the implications for teacher-training of this development and the arrangements for the spending of Education Support Grant money in England, Wales and Northern Ireland indicate that the Department of Education and Science also recognise the importance of supporting teachers in their use of micros in the classroom. Increasingly, consideration needs to be given to alternative ways of providing this support for teachers and there are lessons to be learned from the commercial world where business packages are supported by good documentation as well as computer based tutorial material to facilitate its use by purchasers.

The investment in training and in the preparation of additional classroom material for packages such as Quest and Find is such that their lifetime is clearly going to be greater than that of the machines for which they were originally developed. It will be essential, therefore, that all software is now written in such a way that it can be easily adapted to new machines when they appear. Equally, authorities must consider which software packages will run on machines which they are purchasing for their schools.

PORTABLE EDUCATIONAL SOFTWARE

In this article the term portable is used in a technical sense to describe programs which will run on machines produced by different manufacturers and which provide similar facilities in different ways. King's College (perhaps still better known as Chelsea College) has been using standard libraries for the production of educational programs in BASIC and PASCAL for some years. Recently, the Inner London Educational Computer Centre (ILECC) co-operated, initially with the MEP Software Unit and latterly with the Scottish Council for Educational Technology (SCET), in the development of a set of routines which will be available on the RM Nimbus, IBM pc and Acorn Archimedes machines and which will make programs written using these routines extremely portable.

However, it must not be imagined that the use of such standard libraries will solve all problems relating to portability of software. It will make it very easy to deal with differences in screen resolution, but there may be occasions in which the resolutions are sufficiently different that, although the program runs successfully, some re-design of screen layout may still be required. This leads on to the idea that as well as using standard software libraries for writing programs there should be some agreement on the range of facilities which the microcomputer should provide. The need for such standards was expressed in "Microcomputers in Scottish Schools: A National Plan" (ref 2) and the need to follow up its recommendations is more pressing as schools consider the possible advantages of machines such as Acorn Archimedes, RM Nimbus pc and AX, Apple Macintosh, IBM pc, Amstrad pc 1640, Commodore Amiga and others.

The work done by ILECC and SCET is only part of that needed for the area of graphics alone. Other problem areas, such as the use of windowing and menuing systems, file handling, sound and the use of a range of peripherals, also need to be addressed. Such a task is clearly beyond the resources of a single organisation. Central government funding and co-ordination will be necessary if the best possible use is to be made of the limited resources available. It is essential that duplication of effort, particularly by software developers, is avoided and SCET has proposed a collaborative development model in its "Revised Strategy" (ref 3).

There is a fair measure of agreement about the problems faced by educational software developers. The Educational Software Developers Forum (ESDF) which meets regularly at the headquarters of the Microelectronics Education Support Unit (MESU) has also considered these issues and has published its views in "The Future Direction of Educational Software" (ref 4). The Ministry of Education in Ontario, Canada, has recently published a draft specification for microcomputers (ref 5) which will be purchased for schools in that province at the end of the 1980s and into the 1990s. This document has, at its heart, the definition of a standard software interface which will allow the development of programs which run on a range of machines, so long as they meet the specification.

OTHER BENEFITS OF STANDARDISATION

One of the most striking developments in the computer industry in recent years has been the emergence of the Apple Macintosh system. Apple Corporation are clearly committed to the development of the personal computer which is easy to use and meets individual needs. Great care has been taken to protect inexperienced users from the intricacies of a traditional operating system. Apple have also tried to give a high level of support to software developers and this has resulted in fewer compatibility problems with later versions of the Macintosh system and in a consistent approach to software design which helps users. Once a few basic concepts about the use of the Macintosh mouse and windowing system have been grasped it is surprisingly easy to use a variety of different packages. This is largely because common functions such as loading and saving data, editing text and using different fonts and type styles are presented in identical ways in different programs since the appropriate basic tools are provided by Apple and not by the software developer.

However, in spite of its many virtues, the Macintosh fails to meet one very important requirement for an educational microcomputer. Authorities, particularly in Scotland, are acutely aware of their dependence on one company for the supply of its educational microcomputers and they have come to the conclusion that this is not a good position to be in. Dependence on a single source for hardware or software is too dangerous in a market as volatile as that of the computer industry. The aim must now be to build on past experience, including the advantages of the Macintosh system, and to define a non-proprietary environment which can be freely implemented by manufacturers and used by software developers. This will not be easy to implement. It will be very difficult to ensure that an appropriate balance is maintained between insisting on the use of existing or emerging standards and imposing a burden on suppliers which will push prices of systems up to an unacceptable level. It is surely not impossible for a select group representing all interested parties to come up with a scheme which will meet educational requirements and yet still be attractive to the major companies already in the market. This must apply both to the domestic scene, in which Acorn and Research Machines are the major machine suppliers and to the world market so that volume producers such as Apple, Atari, Commodore and IBM can be involved.

CONCLUSIONS

There are two other important ingredients. The first is a commitment to the exercise which should be reflected in a resolve to state carefully what is required and insist on its delivery. Also, there is a need for better long term planning on the part of central government towards expenditure in this area. In the past there has been insufficient co-ordination of the efforts of different organisations and this should not be allowed to continue. Further co-operation with other countries will ensure that there is greater choice for authorities in this country and wider markets for sales of hardware and software for UK companies. The time seems right for the establishment of a collaborative development programme involving local and central government organisations, manufacturers and software developers which would take account of developments in other countries. The opportunity is there - will we take it?

REFERENCES

1. B T Bellis, Report of the Computers and the Schools Committee, HMSO, 1972
2. SCET, Microcomputers in Scottish Schools: A National Plan, 1984
3. SCET, The Revised Strategy, 1987
4. ESDF, The Future Direction of Educational Software, MESU, 1987
5. Computers in Education Centre, Functional Requirements for Microcomputers for Educational Use in Ontario Schools, Ontario Ministry of Education, 1987

SOFTWARE PORTABILITY - FUTUREPROOFING THE FUTURE

HUGO DAVENPORT

HISTORICAL PERSPECTIVE

If we were to assign, arbitrarily, 1945 as the start of the Age of the Computer, we could equally well say that the software portability problem first raised its head in 1945. It is not too much of an exaggeration to say that no two processors, let alone computers, were the same. The owners and users of these machines were military and university research laboratories. In the case of Government establishments, the total non-portability of software was a positive benefit but, as soon as academic installations were used for topics not directly associated with computing science itself, the lack of machine to machine portability began to affect the migration of researchers from one establishment to another quite severely, since programs written for one machine were totally non-portable to another. Hence a researcher would have to re-write any useful programs he had every time he changed jobs. Within a given establishment there were fewer problems since the early machines had long lifetimes (EDSAC, at Cambridge, was only de-commissioned in 1964).

All software was written initially in machine code, later in autocodes or assembler languages. This in itself was a major breakthrough, but the crucial aid to software portability was the introduction of high level languages such as FORTRAN and COBOL during the '50s and BASIC during the '60s. Quite apart from being aids to software productivity, they also solved the portability problem to a very large degree. This was because the standard I/O device everywhere was the ASR 33 Teletype and because only two data interchange media - punched tape and punched cards - were commonly used. Porting a program thus boiled down to the process of taking a paper tape, recompiling the source (and editing appropriately) and running the new program.

The main exception to this situation was in graphics-intensive applications such as CAD since there were a wide variety of graphics devices, all of which had very different characteristics. It is not surprising that all early graphics standards (Plot-10, HPGL and GINO) were responses to this need. At present there is still no pre-eminent graphics standard, although the combination of Unix and X-windows may triumph on largish machines.

The emergence of standard high level langauges such as ISO-PASCAL, ANSI C and FORTRAN 77 has made a major impact on portability problems, although they do not address the question of graphics; neither does the most widespread (C) provide more than a rudimentary interface to the filing system.

THE CURRENT SITUATION

The last ten years has seen the introduction and proliferation ofthe low cost microcomputer in a bewildering variety of types. The rate of technical advance has been breakneck and shows no sign of slackening. This has been fuelled by major advances in integrated circuit technology and by improvements in CAD techniques which make it possible to reduce the design cycle for a new microcomputer product to less than six months. In conjunction with this we must consider the state of the art in CPU design. All the traditional processor families were, even 4 or 5 years ago, regarded as obsolescent by hardware designers. Chips such as the 68020 and 80386 represent the last of their lines. The next generation of processors (78000, 29000, Clipper, Transputer, H32 and ARM to name but a few) are all RISC machines with massive power. These are already finding their way into low cost computers.

There seems to be little hope in hardware standardisation unless one is prepared to accept the certainty of rapid obsolescence.

The situation is no less confused where operating systems are concerned. Unix has hardly touched the world of microcomputers, leaving a plethora of proprietary processor-specific operating systems led by MS DOS in terms of popularity. Within the MS DOS world itself there are, however, a multiplicity of graphics cards to be supported. Even the future of MS DOS is in question with the introduction of OS/2.

In the educational arena there is an amazing variety of different types of computer in service. To name just a few : Apple II, MAC, IBM PC, XT, AT, Commodore 64, Atari, Thomson, Nimbus, Acorn, Tulip and Compis are all used in schools on a major scale.

This gives software developers some major problems, since to reach the widest possible market, a multiplicity of versions of any given title must be generated, a painful necessity in a market which is notoriously tough on margins. Software portability is the key solution to this.

LEVELS OF PORTABILITY

How portable is portable? We can define a number of levels of portability for software (and data).

a) Portability to machines of identical model only (ie non-portable in normal terms).

b) Partial source level portability (ie. portable with recompilation and some re-writing of key sections of code such as that for graphics).

c) Total source level portability

(It is assumed in the above cases that some means exists to transfer source code from one system to another)

d) Total source level portability together with data portability at media level.

e) Total source, object and data portability at media level.

f) Total source, object, load module and data portability at media level.

The difficulty of achieving each level increases substantially towards the end of this list.

The benefits of portability also increase as one moves down the list. Generally speaking, we are at level (b) for programs written in C and normally have a fair amount of versioning to do when porting an application. This task is made substantially easier if a standard graphics environment exists on both the source and target systems. (Examples are GEM and X-windows.) Standard graphics libraries also provide a similar degree of portability. The closer we get to level (c), the better from the point of view of the developer. At this point, all the developer has to do is to recompile for a different target, typically a very short job. However, he still has to supply different versions for different targets, and the user has to have multiple versions if he has more than one type of target. This is a position favourable to the developer (he sells more products) but less so to the user (who has to buy extra products). Moving to level (d) benefits both the user and the developer as it allows free data (including source code) interchange by disk, link or network. It also, in effect, calls for a common filing system which can be implemented on all targets or at least the provision of a file format translator. Neither of these are particularly easy to implement and although many translation utilities exist, they can seldom be said to be transparent to the user. The ideal solution is a common filing system.

Levels (e) and (f) provide the ability to obtain program portability between different targets at media level (with differing degrees of convenience). This mainly benefits the user since he now only has to buy one product to cover a range of machines. For the developer, it results in savings in inventory at the expense of sales revenue.

AN APPROACH TO TOTAL SOFTWARE PORTABILITY

The following sections outline the approach to total software portability which has been taken by European Educational Software PLC (E2S). It is not suggested that this is the only approach and it is not guaranteed that it is truly universal, but it does provide an example from which to outline the reasoning behind the evolution of a software portability aid for use on small targets.

The project had its origins in a UK Government initiative to establish a common UK standard for microcomputer operating systems. This project has been known as VM within E2S but to avoid confusion with existing products for use in mini-computers, it will be referred to as EVM for the remainder of this paper.

The aim of E2S was to provide total portability of applications software for a wide variety of targets in use in education. The multiplicity of processor types in use has led us to adopt a virtual machine approach. The EVM itself is specified in terms of an instruction set which can be implemented either in the form of processor-specific interpreters or processor-specific code generators. This intermediate code is called V-Code and is in many ways similar to other intermediate codes such as O-Code, F-Code and P-Code. The C language was selected as the most flexible standard high level language and V-Code is optimised for C. Key features of V-Code are :

- Optimised for compilation from C
- Compactness - typically 50% to 80% of native code
- Speed of run-time interpretation
- RISC-like instruction set
- Implementable on a wide variety of 16 and 32 bit processors

Having made a start on the definition of the virtual processor the next stage was to define the environment in which it existed. Initially it was envisaged that the EVM would be part of a shell round the native operating system. This route looked attractive but for the maintenance problems and but for the implications on likely performance. As a result, it was decided to design a complete portable operating system. Given this freedom it was determined that the operating system should be multi-tasking, mainly because it was envisaged that, in the future, multi-tasking would be demanded by educational applications, especially by generic and utility software. In addition, the task of designing and integrating a complete operating system would be simplified if a multi-tasking kernel were implemented. The resulting O/S kernel features are :

- Multi-tasking, message passing O/S
- Time slicing for equal priority processes
- Simple design for portability
- 2000 messages/second (on an IBM PC)

The key perceived requirements for the filing system were :

- Multi-user for use on networks
- Support for networking
- File access control
- File locking
- Fully hierarchical directory structure
- Media compatibility between drives of similar type

The EVM filing system provides these features. It will be noticed that file locking is provided at file level only, not at record or field level. This restricts the use of shared files in networked database systems if only the basic EVM filing system features are used, but it was felt that the complexity involved in a true multi-access database system belonged in the database application rather than the filing system.

Sound and music are problem areas because of the enormous variation in the capability of the target hardware, ranging from BEEP to multi-voice stereo sound. The EVM sound system will provide a comprehensive set of sound primitives which will be implemented in varying degrees of completeness depending on the target hardware. External instruments will be accessible via MIDI, so that even a target with no integral sound facility will be able to drive MIDI instruments. The main impact of sound on the rest of EVM is that the kernel has been designed to support the real-time requirements of music, providing a guaranteed minimum time interval of 10ms.

As we have seen, the main hinderance to portability is the multiplicity of different graphics systems in different targets. This has not surprisingly proved to be one of the most difficult areas to tackle. One of the more straightforward ways of approaching this is to implement a standard graphics library together with a series of target-dependant screen drivers for different targets. This is the approach adopted by ILECC in their IGS project. It has a number of cogent advantages, not least that it can be extended easily and with minimum pain to the developer. The EVM team were faced with an added problem because of the multi-tasking capability of EVM. This dictated the neccesity for a full-blown window management system and all that this entailed.

As far as the graphics itself is concerned, the starting point was the GKS primitives such as polymarker and polyline and associated functions. To these have been added higher level functions to provide circles and ellipses etc. together with a set of bitmap and texture operations not supported in GKS.

The use of windows actually eases the portability problems arising from different screen sizes since the user has no prior expectation of any given window size and hence the absolute resolution and size of screen are of less importance. More important has been the provision of the ability to cope with pixels of different aspect ratios and to provide machine-independent graphical representation formats. Both bitmap and vector graphic representations are supported, with bitmaps up to 8K x 8K logical cells (more than enough to deal with most hardcopy output devices without the use of multiple bitmaps). Multiple font working and icons are, naturally, supported. The windowing and graphics system is supported by a resource management system. The object of this is to isolate machine and spoken language dependencies from the applications code. Resource files contain a variety of resource types, such as fonts, menus, dialogue boxes, text strings, images, patterns and sounds, and these can be edited with a variety of resource editors. As a result, applications are both easily generated and tailored. Inevitably the user interface is somewhat MAC-like with the advantage that it supports not only mouse actions but also keyboard input both for cursor keys (when no mouse is installed) and for command line inputs. Keyboard and mouse inputs can be arbitrarily mixed and command files are also supported. The reasons for adopting this approach were that in many targets mice are not fitted or supported and also that a command line interface is more appropriate than a mouse driven interface in many situations.

The programming environment, as mentioned above, is oriented towards C but other compiled languages, such as PASCAL, will be provided in the future. The first compiler is an ANSI standard optimising C compiler. Libraries can be shared for optimum use of memory.

Compiled modules will be linked to generate a V-Code program file which can be either loaded and interpreted directly or assembled on the target to generate a native code executable program.

An interpreted BASIC, compatible in most respects with Acorn BBC BASIC IV, has also been written to give the end user an easy-to-use programming langauge.

Until the project is complete, it will be difficult to give hard and fast answers to many quantative questions about performance. However the performance targets we have set ourselves are :

* Size - 250K including the run-time library
* Message passing rate : 2000 per second (on a PC)
* Interrupt response time : 2 microseconds

The size is comparable with resident MS DOS plus MS windows, but V-Code gives up to 50% reduction in executable code size. In addition, the EVM provides much that would otherwise have to be incorporated in program code which should further compact the size for a given application.

As far as speed of interpretation is concerned, most of the time spent by the target processor will be spent in executing operating system functions in machine code. It is not anticipated that more than a 10-20% speed penalty will be incurred as a result of interpretation.

SUMMARY

The EVM project represents the only attempt in recent years to develop a portable operating system and integrated graphics environment for small systems with the specific intention of improving applications software portability down to media level. It is believed that most of the major design problems have been tackled successfully and that EVM will prove to be a low cost solution to a major problem facing the developers and users of educational software.

ROMTUT: A SIMPLE COMPUTERIZED-TUTOR-WRITING TEACHING-PARADIGM

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ABSTRACT

To teach computerized tutor writing it is convenient to have simple paradigms similar to the mass-spring-dashpot of mechanics which has been found very useful for teaching vibrations, natural frequencies and resonance while keeping the mathematics simple. A simple paradigm designed to teach roman numerals is presented in the paper together with some program listings and a piece of a session.

INTRODUCTION

A current line of research interest in Computers in Education is applying artificial intelligence to the teaching process [Ref. 1] under the suggestive name "intelligent tutors." To produce intelligent tutors one can use artificial experts in the topic being taught and in tutoring. In general the implementation of any significant artificial expert is a sizeable job. For this reason simple paradigms are needed. ROMTUT is such a paradigm for the teaching of roman numerals. It uses "experts" for teaching the translation of arabic numbers to roman numerals and viceversa. For this purpose it uses simple "rules", not very different in nature to the production rules used in writing computer language interpreters. Since most tutors involve practice exercises of the material being taught and comments are expected whenever errors are made by the students, one of the possibilities is to use similar techniques to those used in giving error diagnostics in interpreters. Comments should be friendly and as self contained as possible (We want to avoid cryptical "SYNTAX ERROR" types of messages.) It is important that the experts have correct and complete rules, since even in textbooks they are seldom complete and correct. One of the most crucial matters is that the rules used coincide as much as possible with the ones the students use in solving problems. When this holds, the comments regarding the failure in applying a certain rule tend to be aducationally meaningful. Additionally, since the most interesting learning situations are those involving errors, the expert should deal with the most commomn mistakes made by students. This requires research into the behavior of students in solving typical problems.

AN INITIAL EXPERT

To translate correctly written roman numerals between 1 and 3999 to arabic numbers one could use the following method which is implemented in the BASIC program shown in Figure 1.

1. Translate letters to numbers using the values: M=1000, D=500, C=100, L=50, X=10, V=5, I=1.

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2. Keep a running total, adding all the values as you go along from left to right in the roman numeral.
3. Keep track of the value of the previous symbol; before you go on to the next symbol, whenever the value of the previous symbol is smaller than the one of the current symbol subtract twice the value of the previous symbol to the running total.

These rules translate correctly MCMLXXXVII=1987, MDCCLXXVI=1776, MCDXCII=1492. However the incorrectly written roman numerals IC, XXXXIIII, and IVXLCDM are not rejected and are translated to 99, 44 and 334 respectively. What is wrong with the "expert rules" given above, particularly since they translate all correctly written roman numerals in the range of validity? For one thing, they are not complete for the case of incorrectly written roman numerals, since, for example, no mention is made that a symbol must not be repeated consecutively more than three times. (In ROMTUT this expert was completed with additional rules to spot and comment errors and was used in conjunction with other experts.) But more important than being complete is that the technique of scanning a symbol at a time, recording the previous symbol, is a good and short computer algorithm but not the technique used by people when they translate roman numerals.

A MORE HUMAN-LIKE EXPERT [Ref. 2]

After some analysis the following was adopted for ROMTUT:

1. Locate from left to right contiguous groups of letters corresponding to thousands, hundreds, tens and units, (some may be missing, corresponding to zero cyphers in the result.)
2. Some of the groups are recognized directly. (Examples: IV and IX.) Others may require auxiliary rules: if symbols are in non-ascending order of value, the group value is the sum of the values of the symbols; for two-symbol groups, if any of the symbols I, X, C precedes one of the two immediately higher symbols, the value of the group is the difference of the values of the larger symbol minus the smaller one. Alternatively one may simply decode by what amounts to a table lookup for each decade as follows:

Thousands: MMM=3000, MM=2000, M=1000
Hundreds: CM=900, CD=400, DCCC=800, DCC=700, DC=600, D=500, CCC=300, CC=200, C=100
Tens: XC=90, XL=40, LXXX=80, LXX=70, LX=60, L=50, XXX=30, XX=20, X=10
Units: IX=9, IV=4, VIII=8, VII=7, VI=6, V=5, III=3, II=2, I=1

The groups should be searched from left to right in the order given. (For example if we find an V, we first make sure it is not preceeded or followed by an I before we conclude it is a 5.) The realization of the technique explained above in BASIC is shown in Figure 2.

TUTOR STRATEGY

The tutor has the following strategy:
1. It contains a main menu to which it returns automatically to allow the student to choose the activity he or she wishes

to engage in. This is somewhat similar to typical spreadsheet practice. Some activities give factual information such as the rules of translation and examples; others provide randomly generated practice exercises. The correct answers are obtained by the experts.
2. It uses several levels of experts (two of which are shown in Figures 1 and 2) to check if the student is following a set of incomplete rules. (For example, the student may consistently translate 99 to IC.) If in the exercises the student gives a correct answer according to a true expert, no comment other than VERY WELL is made. In case of a wrong answer, the different experts generate various comments similar in nature to the error comments of interpreters and compilers with good error comments. (These correspond to calls to soubroutines at lines 300, 400, 500, 700, 800 in Fig. 2, whose listings are not shown.)
3. No global evaluation is provided, nor has there been any attempt to provide a natural language processor. These are important pieces that would enlarge the programs so much that one could hardly call it a "simple paradigm". Paradigms for them would be separate projects.

Space does not allow showing complete listings or sessions. Figure 3 is a translation from Spanish to English of a piece of a session, provided to give the reader the flavor of the program.

CONCLUSION

Paradigms are important in the teaching of complicated material. A simple paradigm for teaching computerized tutor development is discussed in the paper. With it a student can try many ideas in a reasonable amount of time. Possibilities include the substitution and testing of several artificial experts both in the topic being taught as well as in tutoring. Since the topic is quite simple this can be done with a small amount of effort on the part of the student.

REFERENCES

1. T. O'Shea y J. Self, Learning and Teaching with Computers: Artificial Intelligence in Education, Prentice-Hall, Inc., Englewood Cliffs, N.J., (1983).
2. C.H. Repetto, M.E. Linskens y H.B. Fesquet, Matemàtica Moderna: Aritmètica 1, Editorial Kapelusz, Buenos Aires, (1980)

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10 S$="MDCLXVI":FOR I=1 TO 7:READ V(I):NEXT
20 DATA 1000,500,100,50,10,5,1
30 S=0:VA=999999:INPUT "TYPE ROMAN NUMERAL ";R$
40 FOR I=1 TO LEN(R$):FOR J=1 TO LEN(S$):IF MID$(R$,I,1)=
MID$(S$,J,1) THEN V=V(J):S=S+V:GOTO 60
50 NEXT J
60 IF VA<V THEN S=S-2*VA
70 VA=V:NEXT I:PRINT S:GOTO 30
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FIGURE 1 INITIAL EXPERT

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10 DIM M$(3),VM(3),C$(9),VC(9),D$(9),VD(9),U$(9),VU(9)
20 FOR I=1 TO 3:READ M$(I),VM(I):NEXT:FOR I=1 TO 9:READ
C$(I),VC(I):NEXT:FOR I=1 TO 9:READ D$(I),VD(I):NEXT:FOR I=1
TO 9:READ U$(I),VU(I):NEXT
30 DATA MMM,3000,MM,2000,M,1000,CM,900,CD,400,DCCC,800,DCC,
700,DC,600,D,500,CCC,300,CC,200,C,100,XC,90,XL,40,LXXX,80,
LXX,70,LX,60,L,50,XXX,30,XX,20,X,10,IX,9,IV,4,VIII,8,VII,7,
VI,6,V,5,III,3,II,2,I,1
40 S=0:J=1:VM$="":VC$="":VD$="":VU$="":VM=0:VC=0:VD=0:VU=0:N=
1+INT(RND*3999):N$=RIGHT$(STR$(N),LEN(STR$(N))-1):PRINT
"WRITE ROMAN NUMERAL CORRESPONDING TO " N$;:INPUT " ";RR$:
R$=RR$:IF RR$="FIN" THEN END
50 FOR I=1 TO 3:IF INSTR(R$,M$(I))=1 THEN VM$=M$(I):VM=VM(I):
S=S+VM:J=J+LEN(VM$):R$=RIGHT$(R$,LEN(R$)-LEN(M$(I))):I=3
60 NEXT I:FOR I=1 TO 9:IF INSTR(R$,C$(I))=1 THEN VC$=C$(I):
VC=VC(I):S=S+VC:J=J+LEN(VC$):R$=RIGHT$(R$,LEN(R$)-LEN(C$(I)))
:I=9
80 NEXT I:FOR I=1 TO 9:IF INSTR(R$,D$(I))=1 THEN VD$=D$(I):
VD=VD(I):S=S+VD:J=J+LEN(VD$):R$=RIGHT$(R$,LEN(R$)-LEN(D$(I)))
:I=9
100 NEXT I:FOR I=1 TO 9:IF INSTR(R$,U$(I))=1 THEN VU$=U$(I):
VU=VU(I):S=S+VU:J=J+LEN(VU$):R$=RIGHT$(R$,LEN(R$)-LEN(U$(I)))
:I=9
120 NEXT I:IF R$="" AND S=N THEN PRINT "VERY WELL":GOTO 40
140  IF R$="" THEN PRINT "YOU GAVE A VALID ROMAN NUMERAL  BUT
NOT EQUIVALENT TO " N$:GOSUB 300:GOSUB 500:GOTO 40
150  PRINT "THE ROMAN NUMERAL IS INVALID, THE LONGEST LEFT
ADJUSTED VALID PIECE IS " LEFT$(RR$,J-1) "WHICH IS WORTH " S:
GOSUB 800:GOSUB 400:GOSUB 300:GOSUB 700:GOSUB 500:GOTO 40
```

FIGURE 2 A MORE HUMAN-LIKE EXPERT

```
WRITE ROMAN NUMERAL CORRESPONDING TO 3802 ?MMMDCCCII
VERY WELL
WRITE ROMAN NUMERAL CORRESPONDING TO 2815 ?MDCCCXV
YOU GAVE A VALID ROMAN NUMERAL BUT NOT EQUIVALENT TO 2815
THE TRANSLATION OF YOUR NUMBER FROM LEFT TO RIGHT IS:
M:1, DCCC:8, X:1, V:5 THAT MAKES 1815
THE CORRECT TRANSLATION OF 2815 FROM LEFT TO RIGHT IS:
2:MM, 8:DCCC, 1:X, 5:V, THAT MAKES MMDCCCXV
WRITE ROMAN NUMERAL CORRESPONDING TO 2127 ?MDDXXIIIIIII
THE ROMAN NUMERAL IS INVALID, THE LONGEST LEFT ADJUSTED
VALID PIECE IS MD WHICH IS WORTH 1500 (M:1000, D:500).
THE LONGEST RIGHT ADJUSTED VALID PIECE IS III WHICH IS
WORTH 3 (III:3).
IN SYMBOL 3 RULE 5 IS VIOLATED: SIGNS V, L, D SHOULD NOT
APPEAR MORE THAN ONCE.
IF WE DISREGARD ALL RULES EXCEPT THE ADDITIVE AND SUBTRACTIVE
PRINCIPLES YOUR NUMBER WOULD BE WORTH 2127, THE NUMBER ASKED.
THE CORRECT TRANSLATION OF 2127 FROM LEFT TO RIGHT IS:
2:MM, 1:C, 2:XX, 7:VII, WHICH IS MMCXXVII
```

FIGURE 3 PORTION OF EXERCISE SESSION WITH ROMTUT

KNOWLEDE BASED TOOLS (SHELLS) AND CHILDREN

Jon Nichol

ABSTRACT

The introduction of the micro into schools in the late 1970s promised much and delivered little. The emergence of Knowledge Based Tools has suggested that the micro may now play a central role in the learning process of children. The development of such tools and their application promises to be a rich field for both educationalists and developmental and cognitive scientists.

PROLOG SHELLS

1.1. The development of the micro as an educational tool and CAL.

The computer represents a breakthrough in the handling of information on a par with the quill pen and the printing press. In schools the micro´s application as a learning tool has been largely limited to its use as a word processor and for handling LOGO´s turtle graphics.

Of considerable value in promoting learning is the alternative but complementary approach, the use of CAL packages which deal with specific topics, be they the solving of a chemical problem or the piratical adventures of an Elizabethan sea captain on the Spanish Main. In particular CAL packages seem to facilitate a doubly interactive learning environment between both pupil and the micro and pupil and pupil. In the latter case we have a learning enviroment for fostering peer interaction, with hopefully the associated cognitive gains.

But, CAL programs have seen only limited application within the normal curricular provision for secondary school pupils (11-18 year olds). Indeed, instead of being the central route for computer supported pupil learning they increasingly seem to be a Cal-De-Sac.

1.2. PEG-Exeter and PROLOG.

To address the problem of using the micro as a learning tool in 1982 PEG-Exeter began working with 11-14 year old childen within a normal English state secondary school. We used PROLOG as a medium through which both individuals and groups of children could work on historical topics, as we felt its declarative nature and rules based features more closely resembled the patterns of thinking we supported rather than procedural alternatives.

Quickly we realised the impossibility for teachers and pupils to acquire sufficient knowledge of PROLOG to write meaningful PROLOG programs. While a teach-yourself approach to PROLOG might have all kinds of unexpected benefits associated with similar courses on motor-bike maintenance and primitive religion, it had little to recommend it to the normal classroom teacher or the average eleven year old.

1.3. PROLOG Shells.

On St. Valentine's day in 1985 we stumbled across the idea of wrapping up the user-lethal features of PROLOG into a shell, and hiding them away inside our micro's large black box. The hidden PROLOG features were those the student used but did not need to know.

A PROLOG shell is thus a piece of content free software. Consequently the shell users can write programs in their mother tongue (in our case English). Each program can thus reflect pupil understanding of a problem or situation.

1.4. PEG-Exeter Shells.

In our work we identified four main areas for the development of shells which covered the main facets of work within the historical domain. These areas were :

1. Data Processing for handling consistently structured lists
2. Information Handling for dealing with discrete blocks of information
3. Causation/Taxonomies/Simulations/Decision Trees
4. Mental Recreation for the reconstruction of situations and the writing of adventure games

Subsequently we have developed a fifth shell for the language needs of Special Learning Difficulty (Dyslexic) pupils. Also, we have been involved in the production of an Expert System shell for use with students in Further Education.

1.5 Writing the shells, command and menu driven.

The shells were originally written in a command driven form, but have subsequently been modified and extended using a WIMPS environment. With the essential support of project team members the shells have been in continuous use in a small number of schools. Pupils involved have covered a wide spread of ages, 6-18, and abilities, both mainstream and special needs - Specific Learning Difficulties (dyslexic) and deaf.

Both a description and assessment of shell use will be dealt with elsewhere. Below we will briefly discuss the structure of one of the shells and how it may relate to some of the concerns of cognitive scientists.

2.1. Semantic networks, schemas and frames.

"A little learning is a dang'rous thing", and educationalist rush in where cognitive scientists fear to tread. Bearing this qualification in mind, cognitive science's interest since the mid 1960s in knowledge representation with reference to semantic networks, schemas, frames, scripts and connectionism is of direct educational relevance. It is particularly of value in analysing the structure and applications of content free software based upon identifying patterns of thinking within analogous problem solving situations. If at a meta level we can formalise the underlying patterns of thinking we can represent this formalism as a specification for software. In turn the software will help produce a computerised learning environment.

2.2. Software writing - modelling.

Software writing involves a close partnership between the educational researcher, computer scientist, classroom teacher and pupils. The development of software and associated courseware is based upon a detailed analysis of analogous situations within which the pupil is working.

From these analogs we can abstract the common features, and use these to create a model of the functional relationships between the discrete elements. For example, we can thus develop a simple model for simulating decision making. The model contains these linked features.

1. The description of the situation in which the decision is to occur
2. The elaboration of such a description by developing a semantic network at any node within the decision tree
3. The taking of any number of decisions from 1-n at any node
4. A facility to link any node to any other node
5. A facility to weight links between nodes
6. A facility to show the current working of the program
7. A facility to trace the path through the decision tree, and to use this to explain a current situation.
8. A facility to keep scores
9. A facility to forget previous states of the world which no longer influence the current state of the world

10. A facility for previous states of the world to affect the current state of the world - to carry consequences of actions forward.
11. The ability to backtrack from a current node to any node which has been previously been passed through
12. A user friendly interface which contains :

    a word processing environment
    guidance messages at every point for the user
    immediate access to the facilities in 1-11.

2.3. Software and Frames. Minsky´s theory of frames is directly pertinent in how we conceptualise the software based on the model above, and how the pupils use it to show their understanding.

The piece of software represents the fixed points of empty slots in a frame. The empty slots can be filled to produce a particular schema. In turn, the software allows each individual slot, and its relationship to other slots to be modified or replaced. This produces a second linked schema. Thus a pupil program can be visualised as a series of linked schema, which derive their basic identity from the underlying features of the software.

2.4. Software and Knowledge Representation. Elsewhere we have argued that such software allows the user to create micro-worlds. Such micro-worlds reflect the knowledge which the pupils have about a particular topic, and how they have structured it within their minds. Analysis of their writing of programs is also of value for those working on cognitive strategies.

2.5. Software Applications. Although the software was originally written for use within the historical domain, the meta level at which it operates has allowed our pupils to explore a multitude of different topics. These range from writing programs for motor-bike maintenance to an undestanding of primitive religions.

TEXTUAL STRUCTURES IN A COMPUTER BASED WRITERS ASSISTANT SYSTEM

Lyn Pemberton, Mike Sharples

ABSTRACT

The Writer's Assistant system is designed to reduce the cognitive load on the writer during text production, by specifying and managing various constraints on the writing task. Some of these constraints, particularly those relating to the form of the text, may be specified automatically by a system which has knowledge of the prototypical structure of text classes.

CONTEXT

The Writer's Assistant is a system, currently under design, which will assist writers during the process of text production, from the organization of ideas to the production of the final formatted document (ref 1). It is not a language understanding system, nor a tutor in writing techniques, but rather a COGNITIVE SUPPORT SYSTEM, designed to assist a competent human in the execution of a cognitively demanding task. The human writer and the computer-based Assistant build up a common representation of the writing task, in the form of structural and other constraints, and the role of the Assistant is to manage these constraints while the writer creates ideas, text and layout. The Assistant will alert the writer to constraint conflicts, and in some cases, will attempt to satisfy them.

TEXT CLASSES

Many of the constraints with which a writer must reckon, including those of the vocabulary, length, layout, and internal structure of the text, are closely bound to the CLASS (or genre) of text under production, short story or research paper, business letter or birth announcement. This paper looks at the problems involved in defining text classes and considers some of the implications, particularly for the structural organization of the text, of specifying text classes for a Writer's Assistant.

Many writing decisions depend on the class of text being created. Text classes provide a convenient index to sets of constraints on the writing process; for example, a business letter requires a style, a format and an internal structure which are quite different from those of a recipe, an instruction manual or a novel. Given this assumption that text type is a powerful defining force for the writer, it would be useful for the Writer's Assistant to be given some knowledge of the characteristics of these text classes, which it could then use to support the writer. First, however, we need a way of distinguishing between text classes in a way that is acceptable to the writer, so that s/he can easily provide the system with the necessary information to elicit this knowledge.

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We would like a practical classification scheme for texts to conform to the following criteria (ref 2):

a) it should be reliable
b) it should enable us to infer properties of texts in each classe
c) the scheme should span the whole range of possible texts
d) its terms and organization should be familiar to the user

One could imagine simple classification schemes based on, for instance, place of publication, author's birthdate or number of words of over four syllables. Such schemes have appeal - they are watertight and could be applied automatically by the system - but they would not be particularly useful, since they do not enable us to infer any properties of the texts in each class besides those used as the basis for the initial classification.

Theoretical linguistics has produced classification schemes which do allow such inferences, based on other aspects of texts (ref 3). Distinguishing between texts on the basis of the relationship between producer and receiver for example, gives a way of sorting text classes such as personal letters, in which a writer communicates with a single known receiver, from other text classes such as recipes, where a writer aims his/her message at multiple anonymous readers. The problem here is that in order for anything like a complete typology there would have to be a massive proliferation of distinguishing criteria. What is more, such distinctions would constitute a novel and often unintuitive descriptive meta-language for texts, which a prospective user would have to expend much effort in learning.

Fortunately, a typology which does satisfy the criteria listed above is available, implicit in the lexical items used in everyday English to describe texts. We have familiar terms for talking about many aspects of texts such as function, structure, style, content, and participants, at many levels, from the whole text to individual sounds. Many of these characteristics, however, may themselves be inferred from terms used to describe the whole text object at the highest level - words such as "editorial," "recipe," "telegram," "wedding invitation," "weather report" and so on - and it is terms of this latter type which will provide the most useful and productive vocabulary with which to refer to text classes.

Once we know what class of text a writer is creating, we can often draw conclusions about particular aspects of the text. For instance, the TOPIC of a recipe or a weather report is essentially defined by the text class itself. The subject matter or an essay or personal letter, on the other hand, is virtually unconstrained.

Many text classes carry with them a well-defined primary FUNCTION (instruction, narration, persuasion, description, etc), which in turn indicates relationships between text elements and also suggests standard organizational schemas (narratives consist mainly of events ordered in time, descriptions often have a spatial order, arguments may contain schemas of the form "argument, counter-argument, resolution"). Again, other text classes are much freer than this in regard to their function: a letter, a memo, a research paper or a newspaper article, may be used for a large number of different functions, including informing, instructing, reporting, arguing, warning, hypothesising and so on. Knowing a text's class in theses cases does not allow us to draw any firm conclusions about the function it will serve.

Certain text classes imply specific PARTICIPANTS in the communication, thereby determining the style of the document and certain conventional elements (such as the sender's reference in a business letter). Normally, however, the identity of the participants depends on the context and cannot be inferred automatically from the text class. Further constraints are often added by the text's AFFILIATION (the institution for whom the writer is preparing the text, or the writer's personal preferences).

A text class, then, may sometimes, but not always, determine the text's topic, function and participants. The one aspect of a text which may be reliably inferred from its class is its FORM and it is here the Writer's Assistant is able to offer the most help to the writer, specifying the main structural elements of the text and their ordering (if we know a writer intends to produce a letter, then we can assume it will contain, for example, the sender's address, the date, a greeting, a body of text, and a farewell).

FORM is the primary aspect of the text determined by the everyday text classification scheme, with terms denoting other aspects oftern being used as modifiers: the form of a text of a certain class, such as a letter, is further constrained by its function, affiliation, participants and topic, becoming a letter of complaint to a supermarket about defective groceries, a family thank-you letter announcing a competition, and so on.

Text form also offers a good GENERATIVE FOCUS: it specifies a default set of text elements and their orderings. By systematically modifying these, the writer can generate interesting and unconventional texts (a letter with the sender's address at the foot, an editorial in verse, a research paper with no literature survey).

TEXT CLASSES USE

Many useful properties of text form can be specified to a computer-based Writer's Assistant. A writer engaged in composing text with a highly conventionalised form, such as a JOB ADVERT, for instance, can be offered a text specification, indicating the sorts of information s/he might want to include. This specification would in no way compel the writer, but would act as a set of prompts which s/he might choose to follow in his/ her construction of the text. Thus a text specification for a job advert might include a number of categories of information such as "name of employer," "job title," "salary offered," "qualifications sought" and a partial ordering of these elements. It might also suggest a layout and typeface, and indicate, at certain points, set phrases and conventionalised wording. For example, associated with a section indicating "qualifications required," the specification might provide a piece of text such as (1) which might form the basis for composing that section:

> (1) Candidates should be educated to A-level standard and be fluent in at least two European languages. Experience of word-processing would be useful.

This facility would be particularly valuable if the Writer's Assistant were used in an institution with its own characteristic house style, where text specifications could be tailored to this style. An individual user might also want to define his/her own text classes from scratch, if s/he regularly produced documents of a class not supported by the system. Given such a specification, the writer would then be in a position either to abide by it or to omit or add elements in order to create a more original and personal text. The role of the Assistant is to suggest further categories, alert the user to those elements that s/he has selected but not yet included, and to warn when a chosen ordering has been violated (ref 4).

An obvious question at this point is how to determine the appropriate text specification for each text class. We suggest two approaches. First, a writer might be given specifications derived from "exemplary texts": job adverts that have been successful in attracting recruits. These may be quite unconventional, for example, they may contain a short story, or verse, in place of a job description, they may be split across two pages, or they may give a profile of the intended applicant. Although a source of inspiration, they are not so useful in giving central and peripheral elements. The second approach is to provide prototypes for each text type. A prototype is much more like the notion of an average, but one which has been constructed so that it reveals both a common core of constraints and modifications of these special purposes.

Although it is tempting, when producing a description of such prototypes, to suggest that certain elements are essential or obligatory, it would be over-restrictive to specify obligatory categories, since a writer might easily omit apparently vital elements yet still produce a sensible text. It is probably best to see the elements included in the specification as a prototypical "deep structure" for the text class, which the writer may not always choose to realise in the final text. Each constraints in the specification can be given a priority which both defines the order in which the constraints will be applied by the system, and also the "vigour" with which constraint conflicts will be notified to the writer.

A system with knowledge of the characteristics of defined text classes will be a valuable aid in the writing process. By providing the writer with prototypical specifications for particular text classes, the system will free him/her from some of the demands of the writing process, particularly those involved in structuring the text. Familiar everyday terms provide a powerful and reliable vocabulary with which to communicate with the system about text classes.

1. M. Sharples and C.E. O'Malley, "A framework for the design of a Writer's Assistant," in J. Self (ed), Intelligent Computer-Aided Instruction (London: Chapman and Hall, in press).
2. M. Dimter, "On Text Classification," in T.A. van Dijk (ed), Discourse and Literature (Amsterdam: John Benjamins, 1985), pp. 215-230.
3. See E. Ventola, The Structure of Social Interaction (London: Frances Pinter, 1987), for a useful discussion.
4. Sharples and O'Malley discuss such issues as when and how the system should intervene.

The authors acknowledge the support of British Telecom.

TEACHERS, DECISION-MAKING, AND THE SOFTWARE SELECTION PROCESS

D.M. Carey*

ABSTRACT

Introductory courses in Computer Education for teachers typcially include a unit on software selection. Instructors employ lists of features of instructional software as checklists against which individual packages are compared. A cumulative score or rating then determines the desirability of the software package for use in the classroom.

The present study examines the actual practices of teachers as they make decisions about software selection for the classroom. A sample of computing teachers in elementary schools, identified as "computer resource teachers," were interviewed to determine the instructional software features that were deemed important during training, which features are considered important in practice, and their sources of information about software. A comparison between sets of criteria in the first two cases indicates that little congruence exists between sets of criteria for software selection suggested in training and those used in practice.

BACKGROUND

In the late 1970s, the curriculum for an introductory course in computer education typically included a unit or module on "Software Evaluation." The objective of such a unit was purportedly to give teachers skill in identifying desirable criteria for instructional software. Teachers were required to pose such questions as, "Does the software meet its stated objective?" or "Does the software include a record-keeping component?" In order to facilitate this complex process, several agencies developed software evaluation forms. Some forms included spaces for anecdotal remarks and others encouraged the compilation of a composite score. In some cases, special forms were designed by professionals in specialty areas for the evaluation of software for use in areas such as science or for special needs students such as the deaf or the learning disabled.

Requiring participants to complete several evaluations had the added benefit of familiarizing teachers with computer-assisted instruction (CAI) software and documentation. Teachers who examined software with a view to scoring its merits on several criteria were more inclined to examine the performance objectives, read the documentation, identify errors, and match objectives to their own curricular objectives. In this sense, the software evaluation form was a valuable guide to the scrutiny of software.

The term "software evaluation" was something of a misnomer if the formal definition of evaluation in education is examined. The term referred to neither formative nor summative evaluation in the sense that the product was rarely used with its intended users, the students. The process was

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mostly one of review, with teachers practicing decision-making rather than evaluation. In a process similar to textbook adoption, teachers examined the materials and tried to predict how successfully these would improve motivation and achievement.

Teachers now have experience with the selection and use of educational software. With the adoption of more complex packages, the time is right to begin an examination of teachers' decisions with regard to the selection of software. The current study examines teachers' preparation and background in software selection, current practices in the selection of software, and the agents and media that influence teachers' decisions in software selection.

DESIGN OF THE STUDY

The study was conducted in a large urban school district with 83 elementary schools. A sample of 20 schools was selected for the study, and the "computer resource teacher" from each school was interviewed to determine training, current practices, and influences on software selection. The computer resource teacher was chosen as the teacher in each school who is most likely to be using computers and making decisions about which software packages will be utilized in the school.

The interview was conducted in three parts. The first part dealt with training in software selection, including number of hours of training and identification of criteria for software selection emphasized during the training. The second section asked participants to list the software in current use and the criteria used to select this software. The third section asked teachers to identify persons and written materials that were the source of information on which they based their decisions.

Selection criteria, both in the training section and in the section on current practices, were ranked in order of importance. The top five criteria were awarded point scores of 6 to 2, respectively, and any other criteria identified were awarded a point score of 1.

Additionally, an open-ended question was included so that teachers could add any factors they deemed appropriate to describe their software selection methods.

RESULTS

Hours of training in software selection ranged from 0 to 64 hours of training in district inservice and university courses. The number of hours of training averaged 7.5 hours for inservice training and 7 hours for university training, for a total of 14.5 hours.

Among the top scores in criteria for software selection emphasized in training were, in rank order: 1) compatibility with curricular objectives; 2) educational value of content; 3) ease of use; 4) software meets its stated objectives; 5) flexibility or adaptability; 6) correctness of content; 7) appropriate reading level; 8) appropriate feedback; 9) menu-driven; and 10) appropriate motivation.

In the second section, most participants indicated that their primary use of software was from a collection of software from the Minnesota

Educational Computing Corporation (MECC). This software is purchased under license by the school district and is available to teachers for the cost of blank diskettes for copying. Other packages in use were also available at low cost because of a district license and, in a few cases, teachers had software in use for remediation or enrichment for select students.

The top scores for selection criteria for software in current use were awarded to: 1) compatibility with curricular objectives; 2) licensing available in the district; 3) low cost; 4) ease of use; 5) challenging; 6) appealing or interesting to students; 7) appropriate reading level; 8) multiple machine boot capability; 9) uses graphics; and 10) offers variety with respect to current holdings.

In the third section, teachers selected published reviews as their primary source of information about software. The district computer coordinator and the district's published list of recommended software ranked second and third among sources of information for teachers. Teachers also received information from colleagues, both in the school and outside the school. Publishers' catalogs were cited frequently as sources of information about new software.

All teachers stated that they were familiar with the 30-day preview process wherein publishers mail software for preview and the software is returned within 30 days if the decision is made to decline purchase. Most teachers indicated that the process was cumbersome and required too much time. Many stated that they feared they would be unable to return the package in time and the school would be billed or the software would be damaged or lost. Teachers suggested a variety of alternate ways in which software could be previewed.

ANALYSIS OF RESULTS

A comparison of the lists of software selection criteria emphasized in training with the list of criteria that teachers claim in actual practice yields three areas of congruence: 1) compatibility with curricular objectives; 2) ease of use; and 3) appropriate reading level. The results of this study indicate that current practices in software selection do not match suggested procedures in training. Although the top criterion, compatibility with curricular objectives, was most often cited in both training and practice, seven of the top ten criteria differed in the two lists. Recommended practice in the literature on software evaluation suggests an identification of curricular objectives, followed by a search for matching programs, with a preview that includes identifying features that are consistent with sound instructional design and programming practices.

Current software selection practices identified by the teachers interviewed in this study include selection of packages from within the collection of licensed programs in the school district. In other words, if no programs are available relatively free of charge to meet particular objectives, then the computer is not used to enhance the unit as no monies are available for the purchase of the appropriate software. Few of the teachers interviewed were willing to utilize software in the classroom unless a full class set was available.

In general, teachers indicated a desire to keep up to date on new software releases. Their information came largely from sources within the school district, published reviews, and catalogs. Many kept a list of desirable software, but few indicated that they had requested that the district purchase a license for their use.

SUMMARY

The literature on software selection seems to assume that teachers select software from the thousands of available programs, identifying objectives to be met, and narrowing their choices to those packages that best meet the needs of their students. In actual practice, the process is highly centralized in the case of the school district under study. The majority of programs selected for use are chosen because of their low cost and availability under license. Within the collection, teachers identified compatibility with curriculum, ease of use, and interest to students as the main criteria for selection. Student interest was not mentioned as a criterion in training sessions. The likelihood is that the training fails to assume that teachers will test software with their students in the preview process.

Two recommendations emerge from this study. First, software evaluation components in training sessions should be expanded to include information on testing software with students. This component might review measures for evaluating curricular objectives. Furthermore, since student interest and motivation are important to teachers, these criteria should be examined in the context of computer use.

Second, publishers must recognize that widespread use of educational programs will not occur until teachers can obtain programs at a reasonable cost. The educational market differs from other professional markets. Individual CAI programs usually meet a very small proportion of the objectives of school curricula, and teachers cannot spend hundreds of dollars on software purchases. More site licenses should be made available to school districts so that the only cost to teachers is that of copying diskettes and documentation.

BIBLIOGRAPHY

Brownell, G. (1987). Computers and teaching. St. Paul, MN: West.

Carey, D.M., & Gall, M.D. (1986-7). Characteristics of computer using teachers. International Council for Computers in Education SIG Bulletin. 3(2 & 3), 52-54.

Hofmeister, A. (1984). Microcomputer applications in the classroom. New York: Holt, Rinehart and Winston.

Lathrop, A., & Goodson, B. (1983). Courseware in the classroom. Menlo Park, CA: Addison-Wesley.

McCollum, P.D. (1985). Choosing software for a high school chemistry class. Technical Horizons in Education Journal, 13(3), 90-93.

Northwest Regional Educational Laboratory. (1982). Evaluator's guide for microcomputer-based instructional packages. Eugene, OR: International Council for Computers in Education.

COURSEWARE FOR TEACHERS: FACILITATING THE INTRODUCTION OF EDUCATIONAL SOFTWARE

Tamar Feuerstein* and Miriam Schcolnik*

ABSTRACT

The introduction of educational software in schools is often hampered by teachers' lack of knowledge of innovations in the field or of the philosophy underlying the materials. Thus, we have developed two teacher diskettes to accompany the students' reading comprehension courseware. As a result of their utilization, the quantity of CAI increased and the quality of instruction improved. Teachers became more perceptive of the approach and more receptive to CAI.

TEACHERS AND THE IMPLEMENTATION OF CHANGE

Teachers resist change, and especially, technological innovations. This problem was studied (ref 1 & ref 2) mostly from the point of view of the psychological causes for the resistance. Little attention was paid to the influence of the pedagogical approach or philosophy manifested in the program. However, one can probably assume that the pedagogical approach and not the actual teaching medium is at the core of this resistance. As a rule, few teachers are aware of the most recent research findings in their field of teaching, unless the findings have a direct application to the syllabus. Syllabi are slow in absorbing the new information, and teaching materials are slow in reflecting the new knowledge. Consequently, conservative and rather traditional methodologies become a source of concern to the specialists in the field.

Thus, the utilization of innovative educational software in the classroom is often hampered by teachers' lack of suitable educational background, lack of knowledge of the changes of directions or innovations in the field and little or no familiarity with the philosophy underlying the materials. For example, reading comprehension research is a rapidly developing area of investigation, and teachers presented with computer materials for teaching reading comprehension strategies do not always understand why the focus in the materials is not lexical or grammatical.

Teacher guides in book form offer a possible solution, but experience shows that more often than not they are not fully read or properly interpreted. Having developed educational software for the teaching of reading comprehension skills and strategies for English as a Second/Foreign Language (ESL/EFL) (ref 3), and having followed its implementation in the classroom, the necessity for individual or personal teacher orientation through in-service training seminars became obvious. However, due to logistic problems it was impossible to reach large enough numbers of school representatives.

Consequently, we considered the development of educational software for teachers. Questionnaires distributed at in-service training sessions, as well as informal discussions with the teachers suggested the need for such a course. Two teacher diskettes to accompany the students' course were developed.

DESCRIPTION OF TEACHER'S DISKETTES

The teacher's diskettes demand that teachers interact with the computer both as teacher-learners and as student-learners. They include three main components:

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1 - Technical Information

The technical section is very brief. Its main purpose is to dispell a number of common 'myths' concerning the use of computers in the classroom (e.g. one has to be a programmmer to be able to use a computer lesson). In addition, the following are available: Informative screens -- a series of screens providing the information that any student using the courseware needs to know - i.e. how to enter his/her name, what options and help sequences are available in the lessons (e.g. text, glossary, help screens), what the important function keys are (arrow keys, Return). Advisory section -- some guidelines for students when working with the computer (e.g. bring pencil and paper to the computer lesson, be patient, change your answers as many times as you wish, choose the sequence you prefer to follow unless advised otherwise).

2 - A Rationale for the Computer Courseware

In this section, the difference between different types of CAI software is demonstrated, with a rationale for the type adopted as well as for the actual programs in the course.

3 - A Course On Reading Comprehension

The main aim of this section is to present and demonstrate the most common reading skills and strategies in an organized fashion. It includes a brief explanation of each skill, of its pedagogical implications and of the sub-skills it includes, and sample activities taken from the student's programs. After doing each sample activity, teachers participate in a short 'discussion' about the learning value of the specific activity.

Why the skills and strategies are emphasized in this course and how they are organized

Current theories of reading emphasize the actual cognitive or mental processes the reader employs in order to read with comprehension. These theories assume that readers develop certain mental abilities that allow them to process texts. Thus, the goal in teaching reading skills and strategies is their internalization and transfer from one reading text to another with the basic assumption that by exposure to these reading skills and strategies, learners will develop beneficial reading comprehension procedures. These procedures or strategies may have already existed in the learner's first language and for some reason or other were not transferred into his foreign language reading, or they may have never been activated for a particular reader. In either case, the activation of these strategies is beneficial in that it brings awareness of skills previously acquired in the first language, and teaches new skills and strategies not yet internalized.

In the reading comprehension lessons developed for students, two alternative approaches were utilized; the text-centered approach and the strategy-centered approach. In the text-centered approach, the lesson is dependent on the text selected. The skills activated are those most suitable for the specific text. In the strategy-centered approach, the lesson focuses on one or two strategies, and a variety of texts are brought in to serve that specific purpose.

In the teachers' diskettes the strategies are grouped into four main categories: HEURISTICS - all those processes that involve guessing, predicting or inferring; PROCESSES OF ANALYSIS - which include those strategies necessary to analyze a text; PROCESSES OF UNIFICATION - which allow the reader to grasp the globality of the text; and PROCESSES OF EVALUATION - which allow readers to read critically and be aware of the writer's point of view. The following is the general Reading Comprehension menu (In the teacher's diskette this is organized as a main menu and sub-menus within each section).

I. HEURISTICS
    A- Guessing word meanings
    B- Prediction
    C- Inference and implicit information

II. PROCESSES OF ANALYSIS
    A- Locating main ideas
    B- Recognizing examples
    C- Reading for factual information
    D- Classification, comparison and contrast
    E- Definitions

III. PROCESSES OF UNIFICATION
    A- Recognizing generalizations
    B- Understanding logical relations
        1.Cause and effect
        2.Addition and contrast
        3.Anaphora
    C- Logical and chronological sequencing
    D- Summarizing
    E- Other skills

IV. PROCESSES OF EVALUATION
    A- Distinguishing between fact and opinion
    B- Awareness of connotations and bias

Example of one sub-unit:

The teacher chooses Heuristics in the main menu, and Prediction in the inner menu. An explanatory screen gives a short rationale about the importance of prediction in reading and the types of knowledge readers bring to the text, which allow such predictions. The following screen asks the teacher why the previous screen was easy to understand, and focuses on the teacher's expectations. The following screens are a demonstration from a student's diskette: a title, "The Legend of the Two Volcanoes" accompanied by an animation and sound sequence of a volcano in eruption next to a snow-covered mountain. The student now has to predict whether the text will be a historical account, a geography lesson or a story which is told in some area. Feedback to the student's input directs attention to the correct answer. The next few screens are interactive, focussing on the relevant learning strategies used. The teacher's attention is directed to the possible learning that has taken place, possible pitfalls and areas that need clarification.

EDUCATIONAL SOFTWARE FOR TEACHERS - SOME FINDINGS

Through systematic observations in schools and teacher questionnaires (n=19), we found that after the introduction of the teacher's diskettes, the quantity of computer aided instruction (number of hours of computer work per studen.) increased and the quality (pre-computer sessions and post-computer follow up activities) improved. Teachers also expressed more satisfaction with the courseware as it became a more integral part of their curriculum. They showed more interest in the teaching of reading comprehension skills and strategies and a desire to continue using the courseware.

Changes in teacher attitudes to using the materials were noticeable in a few distinct areas:

1. In a way, this can be considered an "introductory CAI computer literacy" course. The very fact that teachers had a "hands on" experience in the learning process with and through computers resulted in a change in attitude (All teachers felt their attitudes about

working with computers were now more positive). 63% of the teachers felt the teacher's diskettes had helped them "understand" their students' problems better, 68% said they could now better appreciate the interactive nature of CAI, all felt they now realized more fully the potentialities of the computer medium. In addition, 84% of the teachers felt that they were now better able to make decisions as to the suitability of certain materials for their student populations.

2. 50% of the teachers felt that the experience had helped them understand the different types of courseware, the distinctions between drill and practice materials and tutorials, and between linear and branching programs with and without remediation.

3. Teachers reported that the Reading Comprehension section was especially useful. 89% of the teachers felt the material had changed their approach to teaching reading comprehension in the class. In informal interviews, 12 teachers reported that this approach was new to them. 95% of the teachers felt that an activity book for classroom use to accompany the courseware was needed. This request resulted in a resource book for teachers (ref 4) by the same authors.

4. Subsequent observations in the classes showed that quantity of instruction with the aid of the computer increased. While before the introduction of the teachers' diskettes average time at the computer per student was 1.5 hours per month, computer lessons were now held more often, and average student time at the computer was 1 hour per week. This was recorded for 8 consecutive weeks.

5. While the first stage of enthusiasm may wear off, the training effect and the change in attitude to the teaching of reading comprehension will probably have a long-term effect. This can be inferred from the very serious attention and interest shown by the participating teachers and by their informal reactions. These ranged from requests for suitable textbooks and background bibliographies to comments such as "I really didn't know what I was doing up to now"; "How come no-one ever told us about this?"; "This approach really makes a lot of sense!"

6. While the Teacher's Guide (documentation of the package) recommended follow up activities in the classroom, observations in the initial stages of development showed that teachers continued with their regular teaching schedule following the computer lesson. When actually pressured into conducting follow up lessons teachers expressed their reluctance to do so. Reasons given were "lack of time", "a lot of preparatory work", "I see no real need for this", etc. Only one teacher conducted follow up activities, reported 'great' results but expressed her concern about the time-consuming nature of lesson preparation. After the introduction of the Teacher's Diskettes, all 19 teachers reported that they were now doing follow up activities. Time ranged from 15 to 45 minutes per week. We regard this as an improvement in the quality of instruction because the computer element does not constitute an isolated encounter with the subject matter but is integrated into the overall instructional plan.

References:

1. Hall G., Teacher concerns as a basis for facilitating and personalizing staff development. Teacher College Rep.80 (1), 36-53, 1978.
2. Cincchelli, Terry and Richard E. Baecher, The Use of Concerns Theory in Inservice Training for Computer Education. Computers in Education, Vol.11, No. 2, pp. 85-93, 1987.
3. Turn On To Reading, Ramot, Tel Aviv University Publishers, 1986. (13 Student diskettes, 2 Teacher diskettes, Teacher's Guide and User's Manual). Available for Apple II and Commodore Computers.
4. Feuerstein, Tamar and Miriam Schcolnik, Enhancing Reading Comprehension, Ramot, Tel Aviv University Publishers, 1987.

THE ROLE OF EDUCATIONAL TECHNOLOGY IN DEVELOPMENT

J.J. Palmer*

ABSTRACT

LDNs (less-developed nations) have many socio-economic problems but scarce economic resources to help solve these problems. Education, combined with high technology, could prove to be the best long-range remedy to assist LDNs in their development. Lack of financial support to replicate existing educational models could be the driving force to propel LDNs into leadership positions in the use of educational technologies. Evidence exists that such technologies can teach more effectively, efficiently, and economically than traditional methodologies. In addition, educational technologies could revolutionize the cognitive development of the LDN population. A risk to LDNs from the transfer of educational technologies could be the loss of their cultural sovereignty. Many diverse groups are working to introduce high technology into the educational systems of LDNs. A need exists for more massive international, national, regional, and local efforts before the "information gap" between LDNs and developed nations can be bridged.

EDUCATION: BASIC DEVELOPMENT TOOL

To some educators and developmentalists, the idea of education in LDNs (less-developed nations) going "high tech," might seem ludicrous. The scarce economic resources of LDNs are generally inadequate to provide even the basics of food, shelter, health care, and education for what constitutes 70 percent of the world's population. While problems of such scope could command the attention of developed nations on a purely humanitarian basis, the interdependence of today's global economy adds a new dimension to efforts directed toward solving the problems of LDNs. All LDN problems possess a certain sense of urgency, but education has been described as the best long-range remedy to help close the widening "information gap" between developed and less-developed nations (ref. 1). Educational technologists, in particular, have the opportunity to ameliorate problems in LDNs that is without precedent.

The inadequacies of current LDN educational systems--shortages of classrooms, teachers, and instructional materials--might make the task of improving LDN education appear quite monumental. However, it is this very lack of highly developed educational systems which could prove to be the catalyst for driving LDNs into leadership positions in the use of educational technologies. Theoretically, the less entrenched a system, the easier to change it (ref. 2).

The brilliant historian/analyst, Rex Nettleford, claims that LDNs are clearly at a new and dangerous moment because they are not developing. Nettleford declares that for development to occur in LDNs, "A revolution must take place in the mind" (ref. 3). Education, then, would appear to be the proper development tool to effect needed change in LDNs. Something more is needed, however, than just frantic attempts to replicate current models of education in LDNs.

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BENEFITS OF EDUCATIONAL TECHNOLOGY FOR LDNS

When education is combined with the new, powerful interactive technologies, its effect can be increased many times. Although technology will not ever replace the human element in teaching, it can provide individual tutoring when teachers are few. Technology can transform any environment into a learning environment when classrooms are nonexistent. Technology can make learning accessible when scheduling might prevent such opportunity. Even more important, evidence exists that technology can teach more --better and faster.

For example, Dr. James Kulik of the Center for Research on Learning and Teaching at the University of Michigan conducted a series of meta-analyses of 100 studies on computer-based education at the elementary, secondary, and adult/continuing education levels. Dr. Kulik concluded that computer-based education improves performance by approximately 10 to 18 percentile points and reduces time for completion of tasks by about one third (ref. 4). In addition to these most encouraging benefits of educational technology, an even more dramatic benefit could be forthcoming for LDNs.

One such benefit is that cognitive learning could be restructured and expanded as individuals in LDNs learn to apply new sources of information acquired from electronic systems to problem solving (ref. 5). Apparently, a common result of education in the school systems of LDNs is that students come to believe that what knowledge they have internalized is correct without giving consideration to the possibility of other external knowledge. Slamecka (ref. 6) explains that the cognitive development of individuals in LDNs has been inhibited by the lack of training in problem solving skills, absence of libraries and reference materials, and large classes emphasizing rote learning. He calls the potential impact of information technology upon the cognitive skills of the LDN population "unsurpassed" and believes that technology holds more promise to make this change than anything else.

RISKS TO LDNS FROM EDUCATIONAL TECHNOLOGY

The transfer of technology to LDN educational systems would not be without risk. Although many risks would be possible, the chief risk--loss of cultural sovereignty--actually accompanies all development efforts. The right of a nation to assert its own identity, preserve its own heritage, and design its own destiny, should not be ignored or underestimated by overly zealous technologists eager to advance LDN educational systems. Educators, technologists, and developmentalists need heightened awareness of this most important cultural risk.

An international leader in the field of interactive technology, Alfred Bork, (ref. 7) illustrates a degree of awareness of the cultural risk which could accompany the infusion of computer-based learning material into LDNs. Bork states, "Cultural differences may be present, but most of these can be taken care of in the translation process." Although Bork does not elaborate upon the nature of the "translation process," recognition of the cultural sensitivity of LDNs would require that such a translation be more than literal.

The cultural dimension of educational technology has also been noted by B.J. Luskin, President of American Interactive Media Inc. Luskin stated that technology has no geographic bounds but that successful software will be intercontinental and have multi-cultural versions (ref. 8). The comments of Bork and Luskin express confidence in the ability of technologists to deal successfully with the risk to LDN cultural sovereignty from educational technology. A comment by Rateau, however, reflects a deeper concern regarding the pervasiveness of the impact of educational technology upon LDN culture.

Rateau (ref. 9) states that informatics (computer-related disciplines) is not culturally neutral; programming languages are largely English based. All current informatics is a reflection of a certain way of thinking and a certain amount of economic and social organization--the products of a rationalist and western culture. Rateau questions whether the use of informatics in LDNs will lead to inevitable increasing dependency upon the developed nations.

Despite such risks, however, many diverse groups are working to introduce high technology into the educational systems of LDNs. Examples include projects sponsored by private enterprise such as Control Data's Plato installations in South Africa, Jamaica, and Grenada (ref. 10). Many distance learning projects are in progress between U.S. and Chinese universities (ref. 11) as well as distance learning networks in the planning stages for British Commonwealth and French-speaking nations (ref. 12). While such international cooperation is to be lauded and continued, massive scale efforts are also needed at national, regional, and local levels. For educational technologists, the opportunities have never been greater to make contributions of global proportion for the ultimate benefit of all humanity.

REFERENCES

1. H Sackman, Computers in Developing Nations (North Holland Publishing Co., Amsterdam, 1981) p 51.
2. L K Emerson, Instructional Delivery Systems (Sept./Oct. 1987) p 4.
3. G A Geyer, The Courier-Journal (Dec. 30, 1987) p A8.
4. L K Emerson, Instructional Delivery Systems (Sept./Oct. 1987) p 10.
5. E B Haas and J G Ruggie, Int'l Studies Quarterly 26/2, 196-197 (1982).
6. V Slamecka, Jrnl of the Am Society for Info Sci 36/3, 181 (1985).
7. A Bork, Byte (Feb. 1987) p 206.
8. B J Luskin, Instructional Delivery Systems (Sept./Oct. 1987) p 11.
9. O Rateau, Computers in Developing Nations (North Holland Publishing Co., Amsterdam, 1981) p 7.
10. L K Emerson, Instructional Delivery Systems (Sept./Oct. 1987) p 4.

11. Instructional Delivery Systems (Sept./Oct. 1987) p 26.

12. The Chronicle of Higher Education (Nov. 18, 1987) p A47.

THE PLIGHT OF DEVELOPING EDUCATIONAL SOFTWARE FOR LESS DEVELOPED COUNTRIES

S.P.Kinzett~

ABSTRACT

After seven years of research and development a software package called POPTRAN is still not marketable. This is due to rapid changes in computer hardware which have important consequences for the production of educational software, particularly in less developed countries. In the Sudan and Kenya problems of purchasing and maintaining hardware mean that developers of educational software must choose hardware for development carefully. Either software developers need to produce programs quicker - possibly resulting in inferior products - or hardware manufacturers must be restrained in their need to continually change their products.

INTRODUCTION

POPTRAN (Population Training) is a package of software designed to meet the needs of administrators, planners and students in higher education, to understand basic demographic concepts. It has been written specifically for less developed countries where expertise in demography is lacking. Let us examine the situation in which POPTRAN finds itself in after several years of research and development.

BRIEF HISTORY

In 1980 Apple II series computers were used extensively in higher education - they were market leaders in microcomputers at that time. Apple along with WANG and a few other computers were also very popular in less developed countries (LDC's). Therefore after three years work on mini-computers (1977-80) the Apple II+ was specified as the ideal machine to develop a package to teach non-demographers some demography in LDC's. Four years later in 1984 POPTRAN was completed - written in UCSD Pascal, using colour graphics, error proof, very "user-friendly" and designed so that anyone could use it if they knew how to switch the computer on. However, because the package took so long to develop the Apple Company had updated their micro-computers several times with the Apple II Apple II+ - Apple IIe - Apple IIc - Apple Lisa and the first Apple Mackintosh just around the corner. POPTRAN worked on the II+ and IIe and to a limited extent on the IIc and so it was decided to field test the package in two LDC's before full marketing in order to revise the programs and the program guides.

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FIELD TRIALS

The first field trial was held in the Sudan in March 1985. An Apple IIe with printer was carried to the Sudan despite assurances that there were three Apple II+ machines at the University of Gezira (Around 200 km south of Khartoum). The "computer room" measured five by three metres and contained three Compaq micros, three Apples, and a very old Commodore Pet. Two of the Apples were working but one of these could not be used because the monitor was broken - despite the technician cannibalising two monitors to try and make one good one! Inside the computers there was more dust than microchips and the printer ribbons were at least 2 years old. The only "good" system was taken away to the Population Centre to a relatively dust-free room where the field trials began. Experience showed that not only were the programs quick and efficient at training personnel in demography but also generated much greater interest than traditional teaching methods. The lack of hardware was unfortunate as so many more people could have benefited from the experience. Whilst there it was also discovered that other software packages were available but very seldom used. For example Wordstar - one of the best known word processing packages - had never been installed onto the Apple because nobody knew how to do it. Other packages were not being used because they did not work properly, the manuals were very poor, or they required some extra hardware.

As a result of the field trial in the Sudan, POPTRAN was modified - especially the written program guides - and a much larger field trial and workshop set up in Nairobi, Kenya in August 1986. Hardware in the form of Apples were plentiful in Nairobi - but mainly at "British" and "foreign" schools - and not in the Universities and government departments where the clientele for POPTRAN lay. After borrowing three computers and bringing another from the UK, a series of four workshops were held. Again the package was evaluated and the results confirmed that POPTRAN was very successful in teaching basic demographic concepts to non-demographers (Henderson, Kinzett and Lockwood, 1986). There were problems though in the cost of computer materials in Kenya. For example a box of ordinary listing paper which would retail for around £12 in the UK was almost £60 in Nairobi. Hire charges for computers were astronomical, as were the cost of spare parts and the computers themselves. Hence many of the computers in Kenya were donated under aid programmes of one sort or another. The one Apple IIe which was in a relevant government department was hidden away in an office with limited access - it had not been used properly since it was put there under an American aid programme. Thus the same fate awaited POPTRAN after the workshops were completed ie: it would be stored with the other software, with the computer, back in the office which few people have access to.

The field trials showed the severe constraints under which successful educational software could operate effectively.

THE CURRENT SITUATION

POPTRAN has eventually materialised, after seven years, in the form of nine program disks, fifteen data disks, a set of program guides (not manuals) and a general user guide. It is a substantial piece of programming and written work. It has been demonstrated that it is efficient at teaching what it is supposed to teach. Virtually every user of POPTRAN has commented on its ease of use. It is also now defunct in its present form.

Seven years is a very long time in the computer hardware world and the triumphant march of new technology thunders on unaware of the devastation it is leaving behind in its wake! Towards the end of 1986 and in 1987 Apple microcomputers were rapidly going out of fashion - sales were down. The company were going through some problems and as a result the Apple Mackintosh was made the number one priority - POPTRAN does not run on an Apple Mac. The Apple IIe was phased out to be replaced by the Apple IIg - POPTRAN does not run on the Apple IIg (3 inch disk drives, different chips etc...) There was a massive upsurge in IBM PC's following revived interest by the large American Corporation resulting from it losing its share of the Micro market - POPTRAN does not run on IBM PC's. The clones and the compatibles of the IBM PC have now flooded the market - literally hundreds of different machines - but POPTRAN does not run on them either.

Therefore the decision has been made - POPTRAN has to be transferred into IBM PC format which will entail a further delay of at least one year and add to the already large cost of producing the package. Fortunately the programs have been written in UCSD Pascal and therefore some of the code can be re-used but all of the graphics routines will have to be re-written and the program guides changed. However with the recent limitations on University research, internationally as well as nationally in the UK, funding for this project may well fall by the wayside and the momentum lost.

LESSONS TO BE LEARNT

Generally speaking developing educational software is a skill which requires different attributes to developing corporate software. If the educational software is to be useful and above all straight forward to use, then care and attention to the smallest details are necessary. The POPTRAN programs developed so far contain many of these attributes - for example although they are teaching demography the "demographic" part of the programs accounts for only five percent of the program - the rest is error proofing, graphics and text routines. The point here is that it takes time to produce a good educational product - particularly if the initial project is large. Time is what the computer hardware producers do not give us - they must bring out a new model every year whether it utilises new technology or not thereby adding to the number of computers to write software for.

THE PLIGHT OF LESS DEVELOPED COUNTRIES

Let us now consider the plight of less developed countries in the field of educational software as highlighted by the POPTRAN experience. First, if researchers are to develop good educational software for use in LDC's, they must be fully aware of what hardware is likely to be available and how much of it there is. POPTRAN identified that there were Apples, but did not envisage the neglect of them, the increasing cost of spare parts and ultimately the death of that model of computer. Dust, heat, power failure and no spare parts are all problems in the Sudan. High prices and commercially orientated markets are problems in Kenya. To give one example - a government institution was not willing to buy an old-technology Apple when the business world was saying that the newest computer around - a "Superbyte XM-4a Powerplus" was the one to get - regardless of whether the software ran on it or not. In the Sudan an informal group of computer users in relief agencies found that most of them were having to write their own software because they had been forced into buying hardware which was either the "best" at that time or what the donor agencies dictated to buy. The software was what they were wanting first - not the hardware.

Secondly, educational software must be developed as quickly as possible before computers in the LDC's become either broken or completely out-of-date. Again POPTRAN was long in the making and as a result needs completely re-writing and not just updating. This is less of a problem at present, as the IBM PC and assorted clones seem to be holding the market. But, inevitably, the large companies will invent a new base chip, which will become the new standard to follow, and the whole problem will recur again. In the more developed world this is less of a problem as institutions can more easily afford new equipment, are more adaptable to new software and this is called "progress" anyway. In the less developed country this "progress" merely means that they slip even further behind, have increasing difficulty getting spare parts for "old" computers and find that no software is being developed for the equipment they have got.

CONCLUSION

Halting the development of new computer technology is simply just not feasible. Authors of educational software will have develop their programs and manuals more quickly in the future and risk lack of quality. Less Developed Countries are also ending up with old computers which they cannot afford to maintain or replace quickly enough. POPTRAN is an attempt to provide LDC's with some quality software. But due to the rapid changes in hardware, the investment of time and money developing POPTRAN has resulted in it being limited to a few specialised institutes.*

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* Overseas Development Administration (UK), United Nations Fund for Population Activities and University College, Cardiff were responsible for funding the POPTRAN project.

CHALLENGES OF THE INFORMATION AGE IN DEVELOPING COUNTRIES AND THE CORRESPONDING ROLE OF HIGHER EDUCATION INSTITUTIONS

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ABSTRACT

The appropriateness of current strategies for innovation and computer-based enhancement of education in developing countries will be analyzed, considering some of the challenges of the information age and the corresponding role of Higher Education Institutions. An illustration will be given of a nation-wide effort in Colombia for promoting the enrichment of education with the support of computer-based working and learning environments.

INTRODUCTION

In a certain way developing countries are lucky, not having many resources for them to jump without enough thinking into the computer age in education. Indeed, education in our countries lacks of so many elements, starting from adequate opportunities for everybody to be educated, including both teachers and learning resources, that computers and the solutions they may bring are not yet in most of our schools. Scarcity in resources has provided our countries some time for them to see and analyze what the role of computers in education should be, facing the challenges of the information age and its impact on our development. However it is, at the same time, depriving our educational system of the potential benefits that computers could provide.

We cannot wait to solve all of the economic problems in education for us to start using computers in this area. We would never start. As computers become part of the production and service sectors in our countries, and as they become more powerful and least expensive, education is required to think and act concernig both "education about computing" and about the "enhancement of education with computing". On the other hand, computers need to be used properly, that is, in a way which maximizes their benefits.

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Having these ideas as a frame of reference let us discuss some of the challenges of the information age in developing countries. They will serve as a frame of reference for analyzing both the definition and implementation of strategies concerning the incorporation of computers in education and the corresponding role of higher education institutions.

CHALLENGES OF THE INFORMATION AGE IN DEVELOPING COUNTRIES

A new industrial and economic revolution is happening at the information age. Because of this, many developing countries are trying to face the challenge of taking the most and the best from this age. It would allow them to keep the pace towards development. However, this is not a simple defy. Besides the establishment of a sound policy for promoting a complete technology transfer, i.e., one which allows us to participate since the research and development phases of the technology cycle, strategic decisions are to be taken in order to avoid major social problems, attached to the limited use of computers by certain groups.

In effect, a second challenge that developing countries face concerning the use of computers is to avoid this to become a new means of widening the gap between people, poor and rich, rural and urban. Information age cannot become, as a means for development, a way for maximizing the social and educational differences between people.

The above two dares are not always taken into account by policy and decision makers. Current policies about the use of computers are not pretty well established regarding both challenges, at least in Colombia. Let us see.

Concerning technology transfer and development of informatics, the public sector has not succeeded in defining a national policy which promotes a real development of the field in our country. Regulations have been provided to allow transference of technological products without damaging the local industry (centered in assembling and distributing computing products). But there are no incentives for the development of local technology, proper solutions to local problems. The private sector, particularly the representatives of computing houses, lead the action as it is profitable for them. But basic and applied research in the field has very scarce resources (this is not a top priority activity) and low incentives (software piracy, for example, is not punished).

Concerning the social benefits linked to democratization of computing, there is not either a strong policy which allows everyone to become computer literate. The Government has created a network of learning centers about computing. They are spread through most of the capitals of the states, and they permit some urban people to enter in contact with computing. This effort is minimum in front of the massive requirement. Unfortunately rural areas are away of this. Besides this, there is not a policy for preparing schools to use computers, when affordable. If computers were provided at this moment, most of our schools would not know what to do with them, since the directors and teachers are not aware of the educational potential and requirements. On the other hand, the protection of local industry of computers has kept personal computers away of most of potential users, since current costs are very high for most of the people.

Under current circumstances, developing countries are not profiting from the Information Age as they should. They are exposed to the impact of computing and informatics but are not making the best use of their potential. A vicious circle tends to appear as existing policies do not seem to help facing the challenges and as new policies are not likely to appear while knowledgeable people are not pushing for them.

THE ROLE OF HIGHER EDUCATION INSTITUTIONS

The above panorama has lead some higher education (hi-ed) institutions to start thinking of ways for breaking the vicious circle.

Hi-ed cannot not be concentrated on preparing resources for the known society, even less concerning informatics. It would be a means of maximizing dependency in the field. On the other hand, hi-ed cannot be away from the definition of policies for development, particularly in this area. Both the productive and the academic sectors have responsibility for advising policy definition concerning informatics. Besides this, Hi-ed cannot keep for its own use the knowledge it has about informatics and its application to different areas. Dissemination of knowledge is required for information and informatics to serve as a mean for development.

With this in mind, at the Systems and Computer Science Department of University of Los Andes in Bogotá, we have taken complementary actions, as they are described below.

EFFORTS AT UNIVERSITY OF LOS ANDES

The development of informatics as a field of knowledge and practice has been one of the major goals of the Systems and Computer Science Department. Because of this at the beggining of the 80's the curriculum was examined and reorientated, overcoming the emphasis on what was immediately needed, computing as support of management. The new curriculum considered that both pre- and post-grade options, should have some kind of specialization, besides acquiring basic skills for working with complex systems and computers. Six research areas were established with this purpose: algorithmic and symbolic informatics, computer-aided design and management, educational informatics, software engineering, data-base systems, basic hardware and software. Each of them intends to foster the development of proper applications to local problems, as well as to help developing the specific field of knowledge.

In the case of educational informatics (E.I.) the action has two emphasis: inner (towards the University) and outer (towards the educational sector).

The first deals with the preparation of human resources able to participate with a sound basis in the development of projects about computer-based education and education about computers. It has a major subproduct in terms of educational solutions (different types of educational software) devoted to solve local educational problems. These are prepared by students with the orientation of an interdisciplinary group including a final user, and specialists in education and computing. As prototypes are accepted by the group, they are tested and adjusted. These efforts help in breaking the ice of people who are not aware of the educational potential of informatics.

The outer line of action is oriented to disseminate information related to the area through a network of institutions and people who are interested in E.I. The E.I. Group has organized a large colection of documents and references about E.I. and created a related data-base. Current information is available in this way to researchers and educational institutions all over the country, on request. A quarterly on E.I. presents a deep view about a selected topic, as well as references of new documents. With the support of Colciencias (acronym of Colombian Institute of Sciences) these services will be free during 1988-1989, as a means of fostering the participation in the network and the development of awareness about E.I. It is hoped that informed people will make good decisions about E.I. when required.

A SIMPLIFIED SEVEN-SIGNED NOTATION FOR MUSIC COURSEWARE

Y. Bukspan[*], B. Feinstein[*]

ABSTRACT

Traditional music instruction suffers from the difficulty of using a notation system comprising over a hundred graphic symbols, presenting a considerable obstacle to very young and/or handicapped learners. This paper reports a CAML courseware package using a simplified notation based on the binary system, and offering a complete alternative to the conventional notation. The system described here consists of seven signs has been applied to elementary music education including special education.

INTRODUCTION

Computer-Assisted Music Instruction (CAML) offers a comprehensive and efficient method for the elementary stages of studying music. No prior musical literacy is required.

The CAML program described here uses MUSIMPLE – an innovative system of music notation which opens new vistas in the field of computer applications to music. MUSIMPLE offers a simplified alternative to the conventional notation. Unlike the multiple-sign standard notation it consists of 7 signs only viz.

1 0 . – = + '

and is therefore extremely advantageous in elementary music education. MUSIMPLE has the potential of replacing the standard notation and in particular it is suited to the individualized tutoring, practice and composition associated with Computer-Aided Music Learning (CAML).

Although many computer programs in the field of music are available, until the advent of MUSIMPLE CAML no means was available to communicate with the user in notational language in a manner appropriate for the music classroom as is done in other subjects taught by computer in schools. This is due to the difficulty in comprehending the multiple-sign existing music notation.

MUSIMPLE offers facilities which support or supplement the music curriculum. It provides a simple solution to the aforementioned problem, by marking the computer keyboard with the appropriate MUSIMPLE indicators as shown below.

MUSIMPLE notation labeled on computer keys:

$$2^{10}\ 3^{110}\ 5^{1111}\ 6^{01}\ 7^{001}\ Q^{1}\ W^{11}\ E^{111}\ R^{1110}\ T^{0}\ Y^{00}\ U^{000}\ I^{1}$$

The mnemotechnical characters . – = and + are used for rests and to notate durations.

The MUSIMPLE method of music playing instruction is presently part of the musical curriculum in The Israeli school system, including special education. Pilot tests have shown that MUSIMPLE can be introduced to children from the age of 4–5 years.

In the standard notation, information regarding pitch and duration is contained in one sign which needs additional information, and it is therefore necessary to remember the key, accidentals, etc. MUSIMPLE notation on the other hand uses separate symbols for each attribute. The symbol for the duration of the note can be written above or following the pitch notation as required, and it is not necessary to memorize these attributes.

MUSIMPLE can be written either from left to right or right to left – a factor which facilitates the writing of music by Hebrew or Arabic-speaking persons. It also permits the music and the words to flow in the same direction when Hebrew or Arabic is used.

The elimination of the stave as used in conventional sheet music and the ease of writing MUSIMPLE makes it possible to write almost simultaneously with the flow of the music.

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The other optional notations (dynamics, staccato, legato, fingering, etc.) remain as in the present standard notation.

THE CAML MUSIMPLE PROGRAM

The program's input is extremely simple, resulting in an almost immediate response time and minimal delay between pressing the key and seeing the display. When the key is pressed, the computer prints the sign containing pitch and duration, and the corresponding audio-note is heard. In other systems it is necessary to enter separately: key, pitch and duration for each note. In MUSIMPLE while you play the music on the computer keyboard, the computer translates it simultaneously into MUSIMPLE notation entering your music while you are actually playing. "Print your music while you play". All this is possible without any need for computer programming knowledge.

These exceptional facilities lead to natural use of the computer as the musical equivalent of a wordprocessor. In fact, it would not be incorrect to say that the MUSIMPLE CAML program can be used as a "musicprocessor". It also provides a very inexpensive and convenient means of printing music.

To summarize: the program contributes to making musical education available to the masses.

The first MUSIMPLE CAML program was developed for the COMMODORE 64 because of its outstanding musical features. This computer has a synthesizer in the ROM with a wide range of sounds and timbre so that 3 different notes can be played simultaneously to produce a chord as well as a diaposen over 3 octaves. The program is written in compiler BASIC.

RATIONALE

The MUSIMPLE notation is based on the abovementioned principle. Its symbols signify the tone-semi-tone progressions and not each tone per se, demonstrating the synergetic behavior of musical patterns, as described by Riemann's "toenend bewegte Form" ("sounding form in progression") while using musical scales or modes forming the elementary foundation of music.

MUSIMPLE is not only a new, simplified and technical aid, but also an expression of a different logic or "Weltanschauung", which might lead to other modes of musical conception. By comparison, the alphabet versus a pictographic set of symbols, or algebraic symbols versus arithmetical numbers. As in algebra, the MUSIMPLE symbols are arbitrarily interchangeable and have no absolute value.

THE PRACTICAL APPLICATION OF MUSIMPLE

Since 1978 experiments have been conducted in several elementary schools as well as in special education sponsored by a scholarship – a grant given for innovation in education by the Ministry of Education.

In 1984 the program was approved for the curriculum of the Department of Computerized Education as well as by the Supervisor General of Music in Israel and is now in operation in the Israeli school system.

CONCLUSION

Today when everything is progressing in all fields of technology, one cannot ignore the influence of the computer on human life. The computer can be harnessed in the development of aesthetic and creative senses and to explain the logic underlying musical theory parallel to other logical systems. Even if the analogy is not so simple and unambiguous, you can see in this experiment a breakthrough towards the rationalization that musical phenomena are based on a mathematical model which serves as a practical notation. This notation fits the new channels of thought which have become possible since the computer has become available to the man in the street.

CAML is a program which offers a package deal for the efficient use of computerized music. It provides:

1. Controlled performance of either improvised music or a given musical text.
2. A guide to musical performance assisted by the computer.
3. The possibility of learning at one's own pace with continuous feedback of the student's progress.

4. For the initiative to remain in the hands of the student throughout.
5. An introduction to musical performance beyond the computer, easy transition to playing professionally, and motivation to study music in a professional framework.

To the student:

a. MUSIMPLE is friendly – it uses the simple signs which already exist on the computer keyboard.
b. It provides perfect simulation of actual playing conditions – there is no need for peripheral accessories nor a separate musical keyboard. The student plays on the computer keyboard and does not need any knowledge of programming.
c. A simple code-decode process is provided; the information is unambiguous and the analytical notation separating pitch and duration facilitates the reading and understanding of their proportional relationships.
d. It is an open program.
e. When playing music from a composition the computer will not respond when an incorrect key is pressed, i.e. when an incorrect note is played.
f. It provides the facility for controlled improvisation and composition.
g. It provides an easy possibility for conversion to the standard notation and for use with conventional instruments.

To the teacher:

Music can be entered into the computer simply by playing on the computer keyboard.

To the musicologist:

MUSIMPLE provides the possibility of building a database for research purposes, e.g. to examine redundancies of sounds and/or musical intervals and comparisons, etc.

FUTURE POSSIBILITIES

We can look forward to: (a) the development of a compiler from one musical language to another, to translate from MUSIMPLE to standard notation and vice versa, and to build the bridge between the standard notation which is not suitable for a computer and MUSIMPLE which is intended for a computer, (b) notation of music by kinetic diagrams appearing together with the flow of the music at the same time as receiving immediate writen feedback in a language understandable by man and machine.

INTERACTIVE LEARNING SYSTEMS FOR THE 90's

Philip Barker

ABSTRACT

An interactive learning system is one that is highly participative. It provides an environment in which either a single learner or a group of collaborative learners can develop a variety of different physical and/or intellectual skills. These skills may be needed in order to perform some technical, social, personal or managerial job function. Such systems may also be used as a general educational resource within many different types of learning and training situation. This paper outlines the nature of interactive learning and also discusses how advanced information processing technologies might be used to fabricate a number of different kinds of computer-based interactive learning environment.

INTRODUCTION

In general learning is often defined as being a process by which a system acquires the data, information, knowledge and skills that are needed to influence its future behaviour and future states of existence. Of course, learning can take place in a variety of different contexts: within machines, in animals and within people. This paper is primarily concerned with the creation of interactive learning environments that are designed for use by people either for skill acquisition or in order to stimulate and foster their intellectual development.

Interactive learning systems are by no means new. They have been in existence for as long as living species have been able to observe and communicate with each other. The history of technology-based interactive learning is, however, more recent. Of course, today, there is a vital need to employ such systems in order to develop more efficient and more effective methods of educating people. This need not only arises in schools but it is also prevalent in the context of adult learning [1]. Furthermore, not only is it imperative to explore new instructional methods within those countries where advanced technology is already established [2] but, it is also important that such exploration should take place within nations that are currently less technologically developed [3,4]. As several authors have discussed elsewhere [5-8], many of the more advanced countries have been using computers to augment educational processes for many decades. Within these countries the term 'computer assisted learning' (or CAL) is often applied to describe, in a collective way, the many different pedagogic applications of computers that are now to be found in the majority of schools and colleges; within the home; and in a whole range of industrial and commercial settings.

The great utility of the computer lies in its ability to provide instructional designers with the technology to facilitate the creation of highly interactive learning systems that support active participative learning. Such systems require high degrees of student involvement coupled with extensive monitoring, the provision of appropriate guidance (through corrective feedback), and opportunities for exploration, practice and rehearsal. The potential of the computer can, of course, be

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significantly enhanced through the use of: (1) high bandwidth local and wide area communication networks; (2) optical storage media; (3) intelligent software; and (4) a wide variety of new and innovative human-computer interaction techniques. Together, these resources provide the means by which sophisticated multi-media instructional workstations can be designed and constructed.

In the subsequent parts of this paper the motivation for using such workstations and the outcomes associated with their use are debated. Some current approaches to workstation design and fabrication are then described. The paper concludes with some predictions about the nature and characteristics of the workstations likely to become available over the next decade.

INTERACTIVE LEARNING

Learning within a computer-based environment can occur through the use of either implicit or explicit CAL strategies. The approach that is used will depend upon both the nature of the pedagogic processes that are to be initiated and the objectives that are to be achieved. A common goal of many CAL applications is to secure within the learner a transition from novice behaviour to expert behaviour within some problem solving domain.

The behaviour of an expert is often characterised by the richness of the set of concepts, rules, models and procedures that are used in any given problem solving situation. Novice problem solvers usually have a less wealthy repertoire of problem solving tools. In an ideal world, provided appropriate instructional/learning methodologies are available, the transition from novice to expert could be envisaged in terms of a direct linear traversal between the novice and the expert states of knowledge. However, in the real world, learning processes go wrong; for one reason or another students start to develop mal-rules, incorrect concepts, wrong models, bad habits and incorrect procedures. If the development of these unwanted side-effects can be detected early enough they can be corrected and removed through remediation, rehabilitation, practice and rehearsal. Learning can thus be brought back on-stream. Of course, in everyday life it is important to realise that humans are subject to a multitude of innate physical and cognitive limitations. The extent of these varies from one person to another. It is therefore not possible to expect that every person will develop expert behaviour within each and every domain of interest. However, in many pedagogic situations there is considerable evidence to suggest that multi-media interactive learning systems can be used to improve and enhance human performance quite considerably. Because of their importance as a tool to support interactive learning, the rest of this paper is concerned with various aspects of the design of multi-media workstations for the support of CAL.

MULTI MEDIA-WORKSTATIONS

A multi-media workstation is one which supports the use of text, sound, graphics and a range of highly participative learning devices [4,5,9]. The particular types of resource used in any given situation will depend upon the nature of the pedagogic processes that are to be initiated. Naturally, within these learning/training processes there is a large emphasis on realism; that is, making the learning experience as near to reality as is possible. This realism can be achieved in a variety of ways: for example, through simulation, game playing, the creation of physical models and by using surrogations. A surrogation is essentially a highly interactive pictorial simulation that depends for its success upon: rapid access to static images and animation; high-speed image manipulation; appropriate use of text and icons; and the provision of any supporting sound effects that may be necessary. The most well-known examples of the principle of surrogation are surrogate experiments and surrogate travel [10]. Interactivity within such systems can be accomplished using a variety of different types of peripheral - such as a concept keyboard, a mouse, a digitiser, a training panel or a touch screen. A particularly useful device for use in the fabrication of multi-media workstations is the 'bit-mapped' screen. Such screens offer a high resolution display. When used in conjunction with appropriate software (such as a window system or an image processing package) and hardware (for example, a video frame store), bit-mapped screens can be used to produce many novel and exciting ways of interacting with a computer system. By means of suitably designed interactive dialogue and appropriate knowledge engineering techniques the student can use screens of this type to explore hyper-text and hyper-image networks; any supporting sound effects can also be accessed if and when they are needed. Of course, the creation of knowledge networks to support this type of interactive learning depends critically upon the availability of suitable media for the storage of large volumes of text, pictures and sound. In this context, optical media such as video disc and compact disc read-only-memory have a very important role to play [1].

NEW TECHNOLOGIES, NEW PARADIGMS AND NEW METAPHORS

The ability of a multi-media workstation to access large volumes of pictorial information is extremely important. Because this information will probably need to be shared between many users the problem of access control needs to be solved. This can easily be achieved through the use of a data base management system. Indeed, this is the approach that we have adopted in our electronic books [10]. It is also used to support the new types of learning paradigm and metaphor that we are currently developing. The successful implementation of these also depends upon the availability of low-cost image processing equipment and the development of algorithms to support a variety of different types of high-speed image manipulation primitive. The principle of surrogation which was described above is fundamental to the implementation of our new learning metaphors ('scrapbooks' and 'shopping baskets'). So too is the creation of suitable types of human-computer dialogue. Our systems employ mixed-mode, multi-media dialogues that are based upon the use of mouse grammars and both paper-based and screen-based icons. Within our workstations the data base facility is an important part of the UIMS (user interface management system). In this context it has two major roles to play. First, it keeps track of the many different kinds of interface that are employed. Second, it maintains a record of the images used within any given surrogation and, at the same time, it keeps details of any picture processing operations that were initiated during the user's interactive dialogue with the system.

CONCLUSION

The successful development of interactive learning environments over the next decade will depend very much on the availability of low-cost image processing equipment and high-speed picture processing techniques. In order to achieve this requirement, and because of the need to be able to create highly reactive and adaptive interaction environments, multi-media workstations will need to incorporate high degrees of parallelism within their architecture. Through the use of appropriate knowledge engineering methods and the adoption of intelligent user interface management systems (probably incorporating sophisticated user models) many of the problems of end-user interface design and courseware production will be 'passed back' to the users themselves. Because of the potential need for much international collaboration (particularly in the areas of science and technology), the ability to connect workstations to an ISDN facility, a satellite broadcasting network and facilities that offer interactive television will also need to be provided.

ACKNOWLEDGEMENTS

This contribution to the conference proceedings represents a very compact summary of a keynote address that was presented at a symposium on 'Innovative Learning Systems and Technologies' which was held at Singapore Polytechnic in October 1987. A complete transcript of that lecture has been submitted to the Association of Educational and Training Technology for publication in the journal 'Programmed Learning and Educational Technology'.

REFERENCES

[1] Barker, P.G., The Potential of Optical Media for Creating Adult Learning Opportunities, Bulletin Leren Van Volwassenen, 20, 165-180, (1987).

[2] Barker, P.G., The Current Status of CAL in Singapore, paper submitted to the British Journal of Educational Technology, (1987).

[3] Wu, C. and Yu, W.R., Potential Applications of CAI in China, Computers and Education, 11(3), 211-213, (1987).

[4] Godfrey, D., Gong, S., Hart, R., Koorland, N. and Smit, S., Project 'Clear Skies': Teaching Computer Science by Computer Based Training and Electronic Messaging in China, The Computer Journal, 30(5), 469-474, (1987).

[5] Barker, P.G. and Yeates, H., Introducing Computer Assisted Learning, (Prentice-Hall, UK, 1985).

[6] Barker, P.G., Author Languages for CAL, (Macmillan, London, 1987).

[7] Bork, A., Learning with Personal Computers, (Harper and Row, NY, 1987).

[8] Solomon, C., Computer Environments for Children, (The MIT Press, Cambridge, MA, 1986).

[9] Barker, P.G., A Practical Introduction to Authoring for Computer Assisted Instruction. Part 8: Multi-media CAL, British Journal of Educational Technology, 18(1), 25-40, (1987).

[10] Barker, P.G. and Manji, K.A., Pictorial Dialogue Methods, Working Paper, Interactive Systems Research Group, School of Information Engineering, Teesside Polytechnic, County Cleveland, UK, (1988).

Video-Integration Strategies in the Spanish Educational System

*J J Leturio Rodriquez,J C de Pablos Ramirez

ABSTRACT

Synopsis

It is a study of the historical process of the decisions and performances taken by the 'Ministerio de Educacion y Ciencia' to succeed in the video-integration at school. The point is to analyse, from 1980 to now, several strategies roused in the managements and commissions that took part in the process, and to check the different mediating agents in the attainment of the main target. Experiences and conclusions are also described.

Contents

a) Period 1980-1986
"Comision Ministerial de Medios Audio-visuales"
(Audiovisual Media Commission)

1. Composition and historical evolution
2. The beginning
3. The 'Mercurio' Project
4. Training programs. Teacher Centres
5. Production of Software
6. Follow up
7. Other activities of the Commission

b) Period 1986
"Programa de Nuevas Tecnologias de la Informacion y de la Comunicacion" (New Technologies Program)

1. Union of 'Mercurio' (video) and 'Atenea' (computer) Projects
2. Equipment policy
3. Training
4. Production of software
5. Follow up
6. Feed-back and applied research
7. Performances with other Innovation Programs:'Prensa-Escuela', Reform of Upper Secondary School, Mainstream, Nursery and Infant Schools, etc

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MODEL TECHNOLOGY SCHOOLS PROJECT

G. Montgomery*, M. Puentes*, J.C. Harrison*, A. Bagby*

ABSTRACT

During the 1987 school year the Monterey Peninsula Unified School District applied for and received a $500,000 grant for each of the next five years to study the use of technology in four schools of the school district (two elementary, one middle school and one high school). These four particular schools are part of the same articulation cycle.

The approach and the guiding theoretical framework of this proposed plan shapes the design, implementation, evaluation, and dissemination of programs to provide a technologically enriched environment in which students can become proactive learners. The goal is to make it possible for students to utilize skills and knowledge acquired from their education (content) combined with the tools now provided by technology to make independent, self-directed, self-regulated decisions that will optimize their ability to solve complex problems both in and outside the classroom. The approach to the use of technology in education envisioned in this project is defined by the project developers as a proactive student-centered approach.

In order to develop a technology enriched environment where students will interact with their learning to greater degrees than is possible without technology, the project proposes four components which include objectives and activities. The four components are the Curriculum Component, Management Component, Community Component and Research/Evaluation/Dissemination Component.

INTRODUCTION

The application for funding for $500,000 for each of the next five years was submitted to the California State Department of Education on April 8, 1987. The proposal included descriptions of goals, objectives and activities for each of the project years. The philosophy, approach and goals represent the broad based involvement of school site staff members, support staff, administration, community and business and industry contributions.

THE APPROACH

The approach and the guiding theoretical framework of this proposed plan shapes the design, implementation, evaluation, and dissemination of programs to provide a technologically enriched environment in which students can become proactive learners. The goal is to make it possible for students to utilize skills and knowledge acquired from

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their education (content) combined with the tools now provided by technology to make independent, self-directed, self-regulated decisions that will optimize their ability to solve complex problems both in and outside the classroom. The approach to the use of technology in education envisioned in this project is defined by the project developers as a proactive student-centered approach.

CURRICULUM COMPONENT

The first year's activities will be concentrated at Manzanita and Ord Terrace elementary schools. Both schools will implement activities in the area of Language Arts - Writing. Microcomputers, ITV and interactive video will be utilized to (1) stimulate writing, (2) reinforce writing skills [CAI], (3) facilitate the revising/editing stages of the writing process [word processing] and (4) illustrate ideas [desk top publishing].

Mathematics - Ord Terrace will utilize an integrated learning system to implement math activities grades kindergarten through five. The activities described include basic skills acquisition and application activity based strategies applied in a networked computer environment. Calculators and manipulatives are key to the activities proposed.

Science - Manzanita will utilize microcomputers, ITV, interactive video and laser disc players to implement science activities grades kindergarten through five. The activities described include both science process skills and science content knowledge acquisition.

In the first year, King Middle School and Monterey High School will pilot activities in the area of math/science utilizing primarily interactive video technologies.

During the second year, the concentration of resources will be at King Middle School. Monterey High School will implement major activities during the third year.

The expansion of educational technology utilization into other curriculum areas will be phased in following the school district's textbook and related materials adoption cycle schedule.

MANAGEMENT COMPONENT

Microcomputers and telecommunication capabilities will be installed to facilitate (1) school site technology management and communication, (2) intradistrict networking for management and communication, (3) statewide networking and data base access. The phase-in of the management activities will occur over three years. Year 1: Elementary schools and one computer station each at King, Monterey High School, District Office and the Instructional Materials Center. Year 2: Expand computer stations at King. Year 3: Expand computer stations at Monterey High School.

COMMUNITY COMPONENT

The activities described in this component include strategies to make school site resources available to parents and students beyond the school day. Access to technology at school sites will allow for (1) tutorial activities, (2) independent interest project activities and (3) recreational activities. These activities will phase-in over the five year project cycle.

DISSEMINATION COMPONENT

There are two basic goals within this component:

-Video production activities for the purpose of teacher training and student tutorial/review.

-Sponsoring summer training institutes. The activities described within this component are designed to provide a meaningful method of sharing technology-based instructional strategies with other schools and districts in the State of California.

PROJECT LEADERSHIP

Four individuals are identified to facilitate project management functions.

RESEARCH AGENDA

The University of California, Santa Cruz, has carefully designed a research agenda to explore systematically the educational benefits resulting from the use of technology. The research agenda poses the following statement of the central learning issue:

-How can instructional uses of educational technology help students to become self-regulated learners?

This central learning issue addresses a desirable long-range outcome of education. It also implies certain constituent learning issues which address the more proximate outcomes:

-How can instructional uses of instructional technology help students to develop and apply higher order thinking skills, including those which are required in accessing and processing information and solving problems?

-How can instructional uses of instructional technology help students to develop and maintain positive attitudes toward learning and toward themselves as learners?

These Constituent Learning Issues are intended to encompass the knowledge, skills, and attitudes which are generally perceived as essential outcomes of elementary and secondary education, and which may be regarded as intertwined with the learner's development of self-regulatory processes.

BUSINESS PARTNERS

The project business and industry partners are:

IBM Corporation
Apple Computer Corporation
CTB/McGraw-Hill
Education Systems Corporation
Teaching Technologies
Unisys
Velan Inc.
Worlds of Wonder
Tandy Corporation/Radio Shack
Columbia Computing Services, Inc.
KQED (ITV)
Sunburst
Scholastic
Lawrence Livermore Laboratory

The business and industry partners have made significant commitments to actively participate in the project's activities. For example, IBM is committed to provide executive sponsorship to this project. Guidance, leadership, and support for a statewide and nationwide perspective will be provided through the staff resource assignments which represent both time and expertise.

Business and industry partners are committed to working cooperatively with the district to facilitate technology design requirements, installation and training support, product development discussions, and consultation to solve problems as they occur.

METROPOLIS - A META-SOFTWARE SYSTEM

J.R. Hegarty* and R.J. Collins*

ABSTRACT

There are well over 1000 items of microcomputer software available to teachers working in special education. Despite existing data-bases and resource lists this is an overwhelming number. Experience shows, moreover, that the number of items of software actually known about by teachers is very small. For effective use to be made of available resources, therefore, it seems that an easy and meaningful way of grouping software needs to be found.

This paper describes such a system, called "METROPOLIS", and the effect of instructing teachers in it. The paper discusses advantages and shortcomings of the METROPOLIS meta-system which is potentially relevant to teachers in many settings.

INTRODUCTION

Partly as a result of Government initiatives over the past six years and partly because of the appeal of the BBC microcomputer many educational establishments in the U.K. now own at least one microcomputer. Special-educational establishments, particularly those for children and adults with learning difficulties, have seen great potential value in microcomputer systems and continue to be interested in new software and hardware devices for students with special needs. Authors and publishers have supported the increasing number of microcomputers, so that a very large number of software programmes is now available. BARDSOFT (ref 1), a database of special-educational software, lists around 1,000 software titles from 167 publishers for the BBC microcomputer alone. As well as commercially available software there are many items belonging to the "public domain" and distributed informally.

Lists of and guides to software are available. Despite these, our experience is that many teachers know little of the vast range of software titles available. Also, teachers have difficulty seeing how individual items of software could fit into their current teaching. Thus it may be that a micro may not be used, or used inappropriately, when good use might be made of it if appropriate software were at hand.

Ignorance of the software now available also leads to the inappropriate commissioning of new software. We are frequently told by teachers working with adults who have learning difficulties that there is little suitable software and they say that more software

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should be written. However, teachers generally cannot specify software precisely. Software subsequently written (often by amateurs) is usually technically sound and ingenious but does not necessarily match curriculum objectives and other user-requirements. New software should ideally be written to complement and extend existing software and should meet real curriculum needs.

These considerations led us to devise a way of grouping software items which would be educationally appropriate and easy to understand and use. We hoped that our system for grouping software would also improve the process of specifying new software.

THE METROPOLIS SYSTEM

The system we devised, which we call METROPOLIS, is based on the extended metaphor of a town which is yet to be built. We introduce the idea by showing the METROPOLIS map, a fictitious, schematic town plan. Since we all have experience of towns, we can readily spot what is shown on the map; for example, parks, factories, or houses can easily be imagined.

We say that the map shows "Sites". These are earmarked for all the things one sees in a community, including factories, houses, cafes, amusement arcades, schools and so on but have not yet been developed. The task of the teacher and the students in a class is to develop any Site in any way they wish.

Let us suppose, then, that a class decides that they are interested in developing a cafe. We assume that they have chosen this because that is educationally relevant and interesting to the group.

We now suggest that the class undertakes this as a project over a period of weeks. That they find out as much as possible, at a relevant conceptual level, about what a cafe is, how it works and what it takes to run one. Clearly this could be tackled in a variety of ways, depending on the skills and interests of the group and on the relevance of such work to the wider curriculum. We assume that a variety of educational resources might be used including computer software.

We assume that the development of a METROPOLIS site is analogous to the process of acquiring knowledge. Until we gain experience of a topic through visits, talking to people, written information and so on we have an undeveloped area of knowledge in our minds. As we gain knowledge a conceptual equivalent to the physical world is constructed in our minds until we have a mental representation of something in the physical world. The teacher's task is to aid a student to encounter real-world things so that a mental equivalent can be created. In work with adults described as "mentally handicapped" (and perhaps in educational work with everyone) the priority is for students to learn about their immediate community.

INTRODUCING TEACHERS TO METROPOLIS

We shall now describe how we introduce METROPOLIS to groups of teachers during "hands on" computer workshops.

In a two-hour session, teachers are taken through three exercises:

(1) The Existing-Software Exercise: each teacher makes a list of the items of software they currently possess in their place of work.

(2) The Site-Finding Exercise: for each item of software listed the teacher writes down an actual location in the community where that item of software would be relevant. Thus, an arcade game would be found in an arcade, a computer simulation of using timetables would be relevant to a bus or train station and so on. In the METROPOLIS terminology, teachers are finding sites for each piece of software they possess.

(3) The Site-Planning Exercise: teachers look through the list of sites created in Exercise 2 to find one which would be a worthwhile and interesting theme for a class project. They then plan a project on that theme to last up to three months. To aid this planning, teachers may complete a detailed form covering key administrative details necessary to the successful completion of the project. We would encourage teachers to incorporate a variety of experiences into the project such as visits, role-plays, discussions, practical exercises as well as work with relevant computer software.

EVALUATION OF METROPOLIS

We have introduced METROPOLIS in the course of "hands-on" computer workshops to over 100 teachers working with adults who have severe and moderate learning difficulties. We have found that teachers are able to complete the three exercises smoothly if they have detailed knowledge of at least some items of computer software and that worthwhile and interesting ideas for project work emerge in a way which is often pleasantly surprising to the teachers. Since the exercises require a detailed knowledge of the software owned by a centre, teachers' ignorance of their own resources is highlighted, so encouraging them to look in more detail at the software they actually have. When planning a "site" they are cued to look for computer software on a particular theme, so giving purpose to searches through existing software lists.

Recently, in the course of a "Curriculum Planning Action Workshop" held at the University of Keele we were privileged to share in four projects which teachers carried out after the METROPOLIS exercises. Each had involved a small group of adult students participating actively in a project of relevance to them. One project was administrative. The teacher had decided to devote time to systematically appraising the 100+ items of software possessed by his centre. He had worked through these and had been helped in this by a small panel of students who tried out particular pieces of software.

The other three projects aimed to develop particular areas of social knowledge, specifically: social sight vocabulary, understanding time presented digitally, and planning a weekend trip away. Each project arose from the METROPOLIS exercises and participants had found them worthwhile. A feature of the three educational projects was the integration of software items in a meaningful way with traditional teaching methods, thus giving the microcomputer a clear and valid role within the curriculum.

DISCUSSION AND CONCLUSIONS

We are confident that METROPOLIS can be used by teachers to plan valuable projects. The three METROPOLIS exercises are straightforward to use in a workshop setting and they produce valuable educational outcomes. In every case, the method succeeds in merging traditional methods with computer software in an educationally valid manner. Moreover, teachers can search for new software with a systematic structure in mind.

We have as yet little experience of the potential value of METROPOLIS as a way of specifying new software. We expect that we shall, during the next year, produce a list of published software potentially suitable for use by adults with learning difficulties grouped by "favourite" (in that they frequently are mentioned in workshops) METROPOLIS sites, such as post office, cafe, or travel. Gaps in software will then be clear and appropriate new software could be then readily specified.

Whilst we have used METROPOLIS with teachers in special education we believe the approach is relevant to teachers in any setting who wish to incorporate computer software items realistically into their curriculum.

REFERENCE

1. Handicapped Person's Research Unit BARDSOFT Database on Special Educational Needs. HPRU, Coach Lane Campus, Polytechnic, Newcastle upon Tyne, England.

ACKNOWLEDGEMENTS

We are grateful to Sue Brown, Nigel Dalby, Liz Hunt and Andrew Philip for permission to give details of their projects and to the Joseph Rowntree Memorial Trust for their financial support of the project.

COMPUTER ASSISTED ENQUIRY TECHNIQUES (CAET): THEIR USE IN DEGREE AND PROFESSIONAL EDUCATION

TONY AYKROYD* AND IAIN GRAY*

ABSTRACT

The paper addresses the following issues:

THE PERCEIVED BENEFITS OF EMPLOYING CAET IN THE CLASSROOM.
The authors discuss their and student perceptions of the benefits derived from use of computer software simulating the audit data collection and judgement process. The paper discusses the reasons why a computer-based approach to teaching the subject was felt to be necessary and the objectives set prior to the development process.

THE PROBLEMS OF DEVELOPING EDUCATIONAL SOFTWARE AND HOW THOSE PROBLEMS WERE OVERCOME.
The paper refers to problems encountered in the development of the software, including: setting educational objectives; defining the scope of the programs; achieving a flexible and user friendly approach to the interrogation of data files; behavioural factors within the development group.

INTRODUCTION

This paper describes the use and development of computer assisted software for teaching purposes. To aid understanding of the circumstances in which the software came to be written and the problems encountered in developing and using it, we set out below brief details of the people taking part in the development and their role:

THE USER: a lecturer in auditing who was looking for ways to simulate the audit process in the classroom. He had substantial auditing experience but none in programming.

THE PREPARER OF THE PROGRAM SPECIFICATION: a lecturer in management accounting with a particular interest in the use of computers in the educational process. He had no auditing background but had experience in programming and program specifications.

THE PROGRAMMERS: The initial writing of the programs was done by an HND student at the Polytechnic and, subsequently, by a professional programmer.

PERCEIVED BENEFITS OF CLASSROOM USE

Auditing is a very practical discipline and one that requires the exercise of considerable judgement by its practitioners. The auditing teacher has to give recognition to the fact that the exercise of judgement is a vital element of the audit process and that the ability to judge comes normally only after considerable experience in practice. Teachers of auditing are also conscious of the fact that the examinations of the professional accounting bodies are frequently practice-

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oriented and that they must face the problem of how to overcome students lack or insufficiency of practical experience. It is increasingly the case that teachers perceive the need to simulate the audit process in the classroom, not that it is possible or desirable to reproduce the process faithfully but that students should be encouraged to think and to seek solutions to realistic problems posed by the teacher. At Sheffield City Polytechnic auditing courses have been designed in such a way that students will learn from their own experiences in the classroom, albeit under the guidance of a skilled teacher This case study-based approach is usefully placed within a framework of auditing theory and an understanding of the role and purpose of audit.

In order to reduce learning by rote and to encourage students to draw logical conclusions the case study has to be carefully devised so that the student can obtain the maximum benefit from the time devoted to it. Good auditing case studies provide students with concentrated experience of the audit situation and to this extent they tend to be unrealistic.

The thoughtful teacher is primarily interested in encouraging students to think, to interpret, to seek solutions and form conclusions. It is recognised, however, that the students do expect the cases used to be reasonably realistic and it became increasingly apparent that they expected information technology to be reflected in the cases. It was known that computer software was being increasingly used by auditors in the interrogation of computer files and it was decided that educational software should be developed to simulate these interrogation procedures. It is important to say that although the software as developed does give students hands-on experience of the use of computers, this was not seen as a main aim as students were already being given such experience through spreadsheet and other accounting software. Set forth below are the perceived objectives of the teacher and the value to the student as perceived by the authors:

TEACHING OBJECTIVES

The teacher wishes to give the student an appreciation of a number of important features of auditing in a computerised organisation and to show him how the computer may be used in the audit context:

- the power of the computer which enables the auditor to carry out procedures which would be expensive or impossible in manual processing systems.
- the need for the auditor to have a detailed knowledge of data on computer files before any attempt is made to access it.
- the need for the auditor to adopt the same if not a higher degree of imagination to the audit of computer systems as would be adopted in relation to manual systems.
- the value of auditing by exception, an approach particularly useful where data are held on computer files.

VALUE TO THE STUDENT

The matters set forth below can be regarded as teaching objectives also, but they have been classified under this heading as they represent a summary of comments made by students on courses internal and external to Sheffield City Polytechnic. It may be added in this context the authors intend to research into student attitudes to the case study approach in the area of information technology but this is as yet not far advanced.

- It provides the student with meaningful hands-on experience with the computer. (By meaningful is meant the use of the computer to obtain a meaningful objective).
- It provides the student with an insight into how powerful the computer can be when properly handled.
- They obtain a clear demonstration of 'being set upon enquiry'.
- It shows the student that use of imagination in the audit process is an important key to auditor effectiveness.
- In the two software packages referred to in this paper, the students are given practical demonstrations of the use of representative and unrepresentative samples in achieving audit objectives.

BRIEF SUMMARIES OF THE SOFTWARE

STATISTICAL SAMPLING IN AUDITING:

This program allows the lecturer to create a file with a built-in general error rate (say 3%) but with a block of items containing a higher error rate (say 60%), thus providing a file lacking homogeneity. It was felt that this would reproduce in the classroom the sort of situation that might arise in practice - a system generally reliable but with a breakdown at one point. The students are expected to take a sample from the file (on a random, every nth, haphazard or block basis) and to determine where further audit effort would be necessary.

COMPUTER ASSISTED ENQUIRY AND AUDIT TECHNIQUES (CAEAT):

This program is more sophisticated than the previous program. It allows the lecturer to create a stock file of up to 2,000 items possessing certain characteristics determined using certain probabilities. The characteristics include stock items where cost exceeds net realisable value, items where minimum stock levels are higher than actual, maximum levels lower than actual, and items with very low and very high turnovers.

The student is provided with details of the information on the file and is expected to use the interrogation package to obtain information that the auditor would use when forming conclusions about the system in use and the value of stock on hand for accounting purposes.

PROGRAM DEVELOPMENT - AN OVERVIEW

A number of problems were encountered in the development of the software and these are discussed briefly below and some guidelines suggested.

The authors' previous experience in program development had been on a one to one basis between a subject specialist and a programmer. It is fair to say that the problems of operating in a team of three with differing needs and perceptions were seriously under-estimated. Although the CAEAT program specification had been discussed by the user and program specifier and agreed in general terms by them, no procedures were laid down for changes seen by the user to be necessary or even merely desirable. In consequence, changes to the specification were made without proper communication between all three members of the group and no proper documentation of the changes was prepared.

There was some confusion over terminology because the participants essentially spoke different languages, but perhaps the greatest problem was that ideas developed so rapidly that there was lack of control and direction. This was also because both the user and program specifier had considerable teaching and administrative duties within the Polytechnic.

The effect of these problems was to delay the application of the CAEAT program but when it was put into use then the interrogation routine was satisfactory but at a time when difficulties were being experienced with the stockfile generation program, making this latter unusable by outside users. This was mainly because insufficient care had been taken to ensure that the program was user friendly with the result that explanations on the screen and routes through the module were confusing.

The development was essentially completed in May 1987 and when the CAEAT and statistical sampling software was used as teaching vehicles for a course for internal auditors in that month the students provided the authors with many new ideas, some of which are being incorporated into the programs.

Much has been learned during the development of these programs and the following suggestions are offered in the hope that they may help others to avoid some of the problems faced by the development group:

- Sufficient time must be given to the development of the aims and objectives of the program.
- Great care must be taken in the preparation of the screen and report formats, bearing in mind that what may make sense to the author may be ambiguous to others.
- The program should be prototyped, that is, mock-ups of the screens should be designed and run on the computer to allow the user to develop a feel for the screens and the flow of the program.
- All calculations should be carefully tested and agreed limits established for all parameters.
- Amendments to the program specification should not be allowed once the program logic is being written. Any possible amendments after this point should be noted and considered for a formal update subsequently.
- A detailed user guide should be prepared with sample exercises.
- Programs should thoroughly tested at all stages.
- Beta testing is particularly important.

USE OF COMPUTERS IN THE EDUCATION OF OPEN UNIVERSITY STUDENTS WITH DISABILITIES

Alistair D N Edwards*

ABSTRACT

In 1988 the Open University is implementing a major new policy on the use of computers in its courses; students taking certain courses will be obliged to have access to a microcomputer. This new policy has many far-reaching consequences, not least for students who are disabled.

In the past most computing in Open University courses has been done by students using terminals in local study centres, linked to the university's mainframe computers. Also a number of students who are disabled have used computers in their studies, principally for word processing written work. By interviewing disabled students who have taken such courses, and surveying other disabled students it has been possible to anticipate to some extent the likely impact of the Home Computing Policy.

Results suggest that for many disabled students the Home Computing policy represents an improvement in their opportunities; now they will be able to study courses involving computers entirely at home. However, a number of problems have also been identified. Hopefully, as many of these have been recognized at an early stage, it will be possible to address them before they affect students directly.

BACKGROUND

This report presents the result of two surveys of a number of Open University students who have disabilities. The objective was to identify the likely effect of a new policy of the university, whereby students taking certain courses will be obliged to use a microcomputer.

The Open University is a distance learning institution. Distance learning has a lot of advantages for many people who are disabled, and the university provides a wide range of special facilities to help students who are disabled to overcome disadvantages which might affect their study. In fact the Open University now has around 3000 students who are classed as disabled, which is more than all the other British universities added together.

In 1987 the university adopted a policy, to come into effect at the beginning of the following year, whereby the use of a microcomputer would be a major and compulsory component of selected courses. Prior to 1988 some courses had contained a practical computing element. Generally, however, this was not a major part of the course and students usually did not have to use a computer at home. For most of these courses students accessed university mainframe computers through terminals in local Study Centres or at Summer Schools. Where students had access to the appropriate equipment (a suitable terminal and a modem), they were allowed to use them to dial into the university's computers instead of using Study Centres. However the university's Academic Computing Service (ACS) was only able to offer a minimal level of support to such students to help them set up the appropriate links.

Among the people who will be affected by these decisions regarding home computing are students with disabilities. In order to cater for some of the particular requirements of these students arrangements have been made to ensure that they will be given support in the provision of equipment and training. The university has established a pilot project for the first year of the Home Computing policy, with the National Federation of Access Centres. Through this arrangement students will receive a

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formal assessment of their requirements and any special adaptations and training required will be supplied.

However, it is difficult to predict what the full implications of the adoption of the policy will be. The purpose of this report is to try to illuminate some of the likely implications for students who are disabled. The approach adopted is to learn as much as possible from past experience.

THE SURVEYS

As mentioned above, Open University courses in the past have included the use of computers, so it is possible to study the effects they have had on the education of students with disabilities. Computers are also used by some students who are disabled as aids to their studying. For the most part, this implies the use the computer as a word processor by people who cannot write manually. A large number of Open University students use computers in this way, and represented another group whose experience was valuable to this project.

Two sources of subjects were used: students selected from lists of those who had taken (Study Centre-based) computing courses, and those who responded to a questionnaire published in a newsletter distributed to all disabled students by the university's Office for Students with Disabilities. In all, thirty nine students responded to one or other of the surveys. Of those, six had no previous experience of using computers while twenty two had taken Open University courses involving computers. Most of the remainder had used computers for word processing in their university studies.

Many forms of disability are likely to affect a person's ability to use a computer. Computers generally display output information on a screen and require input via a keyboard and/or a pointing device, such as a *mouse*. So, broadly, disorders of vision and those which affect manual dexterity are likely to have the most serious detrimental effect on a person's ability to use a computer. Other forms of disability which affect a person's mobility may have an indirect effect on their ability to use computers; some people can use a computer only if it is located in their home.

The aim of this project was to get a rapid impression of the likely impact of the Home Computing policy on disabled students. Speed was important because the policy was being adopted soon, coming into effect in January 1988. It was therefore decided to survey a relatively small number of students rather than taking the time to carry out a more comprehensive study. It was not intended that the surveys should have any statistical significance.

RESULTS

The results of these surveys can only be summarized here. A more complete discussion will be found in reference 1. An important finding was that it seems *unlikely* that many students who are disabled will be deterred from taking courses because they include a home computing element. This was indicated by thirty four of the thirty nine students surveyed in response to a direct question, though some people did qualify their answers; their decision whether to take a home computing course would depend on some of the considerations discussed below, such as finance and the availability of adapted equipment. Of those five who said they would *not* consider taking a home computing course, three were people who had never used a computer before. Only one of the students in the survey said she would not take a computing course because she believed it would be too difficult with her disability (blindness).

As mentioned above, six of the students surveyed had never used computers before. Five of them were female. Other research has been done on the attitudes of women to computing courses (ref. 2), but it is worth questioning whether women who are disabled may represent a doubly-disadvantaged group.

That home computing was not a deterrent to students taking courses was also supported by the evidence of the past behaviour of students. It was clear that courses about computing were particularly attractive to many students who are disabled. They see them as courses in which they can participate fully despite their disability and as a possible aid to improved employment prospects. Indeed, for some students with mobility problems, home computing represents an improvement over the old Study-Centre-based computing courses.

The Home Computing policy will introduce a number of problems for all students, some of which will be more severe for those who are disabled. Finance is an example of such a difficulty. All students will be expected to supply their own home computer. There are a number of schemes available, such as a rental option, to assist students, but there will nevertheless be an appreciable additional financial burden on students. This is likely to be a more significant obstacle for some disabled students, since their earning power is often low; many disabled students are dependent on Social Security. Nearly all of the respondents indicated that the decision whether or not to take a home computing course would depend on the availability of financial assistance.

Although many students indicated that they would favour training in the use of computers none of them felt they needed any special training because of their disability. This is another area in which the needs of students who are disabled are similar to those of all students, but possibly more critical. As distance teaching institution, it is difficult for the Open University to provide personal tutoring of any form, which means that for the most part students will have to rely on course material and manuals.

The previous experience of students confirmed that there are likely to be problems of access to equipment for some of them. Most of the problems reported were very specific - to a particular individual. Since it is not possible to anticipate all such particular requirements, the lesson to be learned is that it is vital that adequate, flexible support facilities are provided such that students can easily get the help they need when they discover a problem.

A common source of physical difficulty is the keyboard. Three students reported that they considered their slowness of typing as a significant disadvantage. Other students had problems in that nearly all computer keyboards require the user to be able to type with both hands. Often the typist must hold down one key (a *shift* or *control* key) while simultaneously pressing a letter or number. One student was unable to do this at all, while another had to use a mouth stick in place of one hand. Another problem is that most computer keyboards have an 'auto-repeat' facility. This can be a major problem for typists of limited dexterity who cannot lift their finger back off a key quickly enough to prevent it repeating.

Five students used adapted equipment for typing. In addition to the one mentioned above, two others used sticks attached to their hands to type. Another two students were unable to use a conventional keyboard at all and used substitute devices. One of them used a *Microwriter*, which is a six-key keypad which can be operated by one hand. The other used an *Elfin* keyboard substitute, which is operated by blowing and sucking on a pipe.

No matter how good the documentation is, there will be a need for other, personal forms of support. It was clear from the surveys that two levels of support were necessary. Firstly students need appropriate equipment, often adapted to their special needs. Then, having acquired equipment, they will need assistance with specific technical and non-technical problems in using it. Students in the past, working in Study Centres, have sometimes lacked this kind of support. Yet it will be even more important when they are working on courses involving a major computing component - which they will be doing in the even greater isolation of their own homes.

The support must be provided on a long-term basis. It will *not* be sufficient for the student to be supplied with a set of equipment, trained in its use and then left to get on themselves. The needs and skills of the student will develop and change. At the same time the technology available will also continue to develop. It is most important that the experience of students reported in the survey, whereby they had struggled with out-of-date equipment, is not repeated by students in the future.

There will be a critical requirement for an easily accessible back-up help facility. This would best be provided for most students by a telephone help line. However, it must also be available to students who cannot use a telephone. An electronic mail hot line would be a very good substitute, but that too would have to be backed up by a postal mail service, since the very problem about which the student is trying to communicate may preclude them from using electronic mail!

Some of the problems which students reported they had experience with using Study Centre terminals illustrated a valuable, more general lesson. The problems might have been avoided if the people selecting the equipment in the first place had thought about the likely difficulties of all the potential students on the courses. If the Home Computing policy can be launched with an awareness of the special needs of some students right from inception, then many problems may be averted all together.

A similarly far-sighted approach is required in the development of software. If properly thought out, programs can be written in such a way that they do not significantly increase the handicapping effect of a person's disability. For example, it was mentioned above that many of the students in the survey were slow at typing. This would have to be borne in mind in the development of some Computer-Aided Learning packages. The formulation of guidelines for software design is the topic of proposed further research.

CONCLUSIONS

Assuming that suitable finance is available, the Home Computing policy is *not* going to disadvantage the majority of students who are disabled. For many it may indeed represent an improvement - in their educational prospects and study opportunities. The problems encountered by all students will generally be very similar: failure of hardware, difficulty understanding technical course material etc. In many cases the only difference for students who are disabled is that the effect of such problems may be more severe. Taking hardware problems, for example; a student who relies on her microcomputer on which she types all her written work is going to have her studies more seriously disrupted by a break-down than one who needs it only for the practical component of a course. One of the students surveyed had experienced the problem of her computer twice breaking down during exams. In one case this had caused her to have to retake the exam.

However, there is a (small) number of students who will be seriously handicapped because they have disabilities which make access to computers difficult. In some cases they may be totally excluded from home computing courses. The university has a responsibility to support and aid these students as much as possible. This implies providing equipment and adaptations as required and supporting research and development of new adaptations where they are not currently available. It is also important that the needs of these students are taken into account as far as possible in the design of course material.

In many ways instituting a major new policy, such as the Home Computing policy, is a step into the unknown. The full effects of such a change are impossible to anticipate and people will have to learn as they go along. The work reported in this paper reduces the degree of uncertainty as far as the effects of the policy on disabled students is concerned. However, the survey reported was limited in scope, and this is unlikely to be the whole story.

REFERENCES

1. A D N Edwards, *The use of computers by disabled students at the Open University, part 1: Previous use of computers*. Open University, Centre for Information Technology in Education, Technical Report (1988).

2. Kirkup, G., *Considering the effect on women students of an increased use of microcomputers in distance education*, Open University, Centre for Information Technology in Education, Technical Report no. 28 (1988).

MICRO-ELECTRONICS FOR THE HANDICAPPED:A NATIONAL PERSPECTIVE

J McCann

ABSTRACT

Since 1982, the Department of Trade and Industry has been seeking to create an awareness of Information Technology (IT) among people with special needs. The Department has encouraged disabled people to ask "What do I need?' rather than 'What is available?'

Whether in education, recreation, working or simply in providing a vital tool for basic communication, IT can enrich the lives of those with special needs. There are now hundreds of different applications available - most of them based on microcomputers - for people with very different disabilities.

INTRODUCTION

The Department of Trade and Industry is keen to continue its commitment to what is now called 'The Concerned Technology' with a further measure providing funds and advice for a variety of projects. It is hoped that this will encourage the improvement of existing IT solutions and the development of new and innovative ways of applying computer technology to those with special needs.

The co-operation of the Department of Health and Social Security, the Department of Education and Science - plus their Scottish equivalents - the Manpower Services Commission and other bodies will add to their effectiveness in this continuing commitment.

TECHNOLOGY AND EDUCATION

In the sphere of education, IT has had a considerable impact. Not only does it offer a new and exciting way to learn, it can also make learning more simple. Used in conjunction with, or in place of, traditional teaching tools like books and blackboards, technology has proved to be adaptable and effective. Often a simple change of software is all it takes to 'customise' a machine to the needs of the individual.

The DTI has backed many computer projects for those with special education needs. In Scotland, for instance, a series of programmes was undertaken, with support from organisations such as the Committee on Special Educational

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Needs, the Convention of Scottish Local Authorities and the Scottish Microelectronics Development Programme. The aim was to see where technology could be applied to create an environment in which young students could develop their intellectual, social and occupational skills to their full potential.

One of the secrets of technology's success in the classroom is its ability to entertain as it teaches. The Edinburgh University-developed Turtle, for example, proved a fascinating piece of equipment. With simple instructions it can be used to draw geometric shapes and introduce sophisticated mathematical concepts.

For the physically disabled student in Further Education, there are many problems associated with taking lecture notes or writing essays. Often the ability to learn is eclipsed by the sheer difficulty involved in performing these tasks. Microcomputers - with wordprocessing facilities - can open new doors to students. Machines which are easy to use give greater freedom to edit scripts and provide a tool which can also help in calculations and the preparation of simple graphics. The process of writing an essay becomes less time-consuming and frustrating, and gives the student more incentive to learn.

All these examples suggest that the latest generation of computers, and an ever-increasing stock of software options, can offer a realistic and exciting alternative for students with special needs in education.

INFORMATION PROVISION

Can I find out easily who has the information I need?
Is the information accurate, current and comprehensive?
Can I get the information I want quickly and when I want it?

With an effective and carefully organised electronic database of information, the answer to all of these questions is 'yes'.

In industry and commerce, computer banks of data are shared by many different people with the same information needs, based in locations situated far afield. The combination of microcomputing and telecommunications permits an information service which is easy to use and to update. Hard-copy directories and lists which are difficult and expensive to update are no longer the only option.

Since the launch of the IT Awarness Programme in 1982, the DTI's Information Technology Division has been actively supporting groups using IT to set up databases of information for disabled people. As well as stimulating an interest in this idea, and providing grants and equipment, the Department has also been keen to offer technical advice and guidance. It advocates the use of established structures in order to create a cost effective and efficient way of providing information.

Many of the databases already established prove that this way of providing an information service can be a 'lifeline' for those with special needs. Perhaps they need to discover what aids are available for use in the home or at work; or maybe they want to find an hotel with certain facilities. Whatever their information needs, electronic databases can help provide the answers.

As well as supporting projects, the DTI has sought to establish communication between groups involved in setting up databases for the disabled. Many ideas for improving current services and for establishing new databases to fill the information gaps have emerged from these discussions. Centralisation and co-operation are keywords for the future. The DTI, together with other Government Departments, is currently seeking ways to achieve a widely available and unified information service network. Centralisation will give a clear picture of who is doing what in the field of information services for handicapped people, while co-operation will ensure that projects do not overlap. Both will make it easier for people to share information.

The DTI has discussed the way forward for this initiative with numerous national bodies and has also strengthened links with the European Commission's Handynet project.

WORKING FROM HOME

One of the trends emerging from the widespread use of IT is the concept of working from home with computer equipment to help carry out job tasks. With advances in new technology, some people believe that working from home will be commonplace before the end of this decade. For employers, this will yield many benefits, such as a reduction in office space needs and overheads.

But this development is particularly exciting for physically disabled people who find it difficult or impossible to travel to work, and some of them have been amongst the first in the UK to try out this new working concept.

They are participating in a DTI project which investigates the practicality of home work units for disabled people. By the end of 1986, 100 units were set up, matching employers with employees. As well as covering the jobs we would normally associate with computers - wordprocessing and programming, - participants have taken jobs involving financial management, book-keeping and instrumentation engineering. And because IT is rapidly entering just about every sphere of industry, there will be many more to add to the list.

It is true that an employer must make an extra commitment to employ a disabled person working from home. However, the results so far show that this contribution is more than made up for by the skills, commitment and enthusiasm of the employee.

TECHNOLOGY AT WORK

The world of work is changing with technology. Employers are discovering that jobs which were once carried out manually can be accomplished more effectively using a combination of computing and telecommunications.

For disabled people, these discoveries bring exciting opportunities with it, they have more freedom to acquire, and use, work skills - at the same time gaining financial independence. With this in mind, the DTI is currently sponsoring a UK-wide project aimed at training unemployed, homebound people in the highly marketable skills of IT and many of the people involved are disabled people. The project aim is ultimately to establish a methodology for successfully training people in IT skills in their own homes and proving that such training can launch them into worthwhile employment.

TECHNOLOGY FOR ALL AGES

Age is no barrier when it comes to technology. Special educational programs capture the imagination of young children while encouraging them to learn. For physically handicapped young people who are keen to take Further Education courses and State exams, technology can help them produce work more easily.

The not-so-young are also getting to grips with computers - and enjoying it. Technology can be both a stimulus and an attraction and, for some, the very means to communication.

The Department of Trade and Industry is responsible for promoting the application of Information Technology - the microelectronics-based combination of computing and telecommunications. The application of IT and the production of its devices are vital for our future economic prosperity. IT in education, health and many other areas beyond traditional manufacturing are supported.

THE SUMIT INTELLIGENT ARITHMETIC TUTOR

Roderick I Nicolson†

ABSTRACT

The SUMIT system is an Intelligent Arithmetic Tutor based on the established non-diagnostic SUMS programs. The enhancement was based on an empirical study which demonstrated that 90% of the errors made by children on addition and multiplication could be attributed to 5 addition bugs and 5 multiplication bugs. SUMIT is of proven effectiveness and runs on a 32K BBC micro.

1. INTRODUCTION

1.1 The BUGGY Intelligent Tutoring System

Traditional Computer Aided Learning (CAL) programs have been criticised on the grounds that they do not *understand* the domain for which they were devised, and so they cannot give the adaptive help expected of a human teacher. This critique proved the stimulus for the creation of Intelligent Tutoring Systems (ITSs) or, the equivalent term, Intelligent CAL, which did understand its domain sufficiently to provide the same adaptive quality of guiance and instruction as a human teacher. It is generally accepted, following Hartley and Sleeman (ref 1), that an adequate ITS needs (at least) three components - knowledge of the subject to be taught (domain knowledge); knowledge of the user's current understanding (user model); and knowledge of the appropriate teaching strategies for that domain and user state (pedagogic knowledge). Not surprisingly, given the lack of explicit knowledge about how to construct any one of the three components, ITSs are notorious for promising much and achieving little, but nonetheless they remain a major focus of applications of AI to education.

Arguably the most promising and tractable domain within school education for the application of ITS is that of school arithmetic - the 'four rules of number'. Indeed, the most cited work in the area is the seminal article by Brown and Burton (ref 2) which demonstrated that it is possible to diagnose 'bugs' or 'malrules' in a child's arithmetic knowledge, and that this diagnostic ability could form the basis of an intelligent arithmetic tutor. Rather surprisingly, this work has never been followed up to produce a system useable within a realistic educational context. With the benefit of hindsight, it is possible to adduce some explanations for this.

1.2 Problems of the BUGGY diagnostic system

(i) Lack of the appropriate pedagogical knowledge. Brown and Burton acknowledged explicitly that their system was essentially diagnostic rather than remedial - it was better at identifying what was wrong than knowing what to do about it! As Ruthven (ref 3) points out, it is hard to integrate into normal teaching practice a system which merely diagnoses 'Bug 6: larger from smaller', and there is a real danger that confusion will result.

(ii) Unmanageable number of bugs. Brown and Burton appeared to delight in the number of possible bugs that could be identified - they claimed 330 bugs for subtraction alone! Consider the teacher's problem in trying to understand what the diagnosed bug meant, never mind remedying it!

(iii) Lack of immediate feedback. It is a commonplace that a major potential strength of CAL material is the ability to give immediate feedback of correct or error responses. By electing to adopt a retrospective analysis of a set of sums in order to identify consistent bug(s) out of their very large pool, Brown and Burton sacrificed their birthright.

(iv) Bug Instability. This is a problem conceded by Brown and Van Lehn in a later paper (ref 4). Some bugs appear to be unstable, in that they appear, disappear, and transmute over the course of a session. This unfortunate fact forced them to propose an ambitious 'Repair Theory' which was supposed to explain which bugs would transmute and why, taking the theory further but diminishing any practical value.

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(v) Medium-dependence. Brown and Burton's corpus of arithmetic sums was provided from a large pencil-and-paper arithmetic study in Nicaragua. There is no guarantee that the bugs identified for that corpus will transfer to other methods of presentation or teaching, in particular, computer-based methods.

(vi) Pragmatic problems. BUGGY was written in InterLISP and worked on a PDP-KL10. It is highly unlikely that it could be ported to a common educational computer such as the British BBC micro.

(vii) Doctrinaire objections. In a rational world one might expect the above problems to act as a spur rather than a damper to further research. Unfortunately, the prevailing CAL philosophy of this decade has been anti-arithmetic, with well-intentioned objections being made that it is at least as valuable to learn alternative skills such as estimation of change. Change estimation is a useful skill, but arithmetic competence - involving knowledge of the principles of arithmetic together with fluency in the arithmetic processes - is the very bedrock of numeracy. Problems in learning arithmetic should stimulate research to solve them, rather than avoidance behaviour.

1.3 Requirements for an Intelligent Arithmetic Tutor

This analysis of the shortcomings of the BUGGY program as a practical tutor of arithmetic leads to the question - what would one expect of an arithmetic ITS? I offer the following suggestions - inevitably they form a personal view:

(i) Target Learning Outcome. Children with minimal understanding of the rules of arithmetic should be able to use the program, and to progress through the intermediate stages of learning to a full understanding both of the principles and the procedures of addition, subtraction, multiplication and division.

(ii) User Interface. The mode of operation must be as close as possible to the standard pencil and paper method normally employed in order to maximise transfer and minimise confusion.

(iii) Feedback. Should be immediate, after every response, in order to pinpoint any errors and to avoid the danger of perseveration of bugs.

(iv) Pedagogic expertise. This should include not only knowledge of how to diagnose and remedy bugs, but also the (more important) knowledge of how to do the sum correctly and how to progress from simple to complex sums in a consistent and effective sequence.

(v) Input of arithmetic sums. The IAT must be capable of adaptive generation of sums at the appropriate difficulty level. It should also be possible to load stored sets of sums from disc.

(vi) Results storage. In addition to standard results summaries presented during the session it should be possible to store a complete 'session log' (including latency information as well as all key presses) on disc which could used subseqently by a teacher either for speeded replay, or replay with just the errors, or could be analysed to give a score/bug breakdown.

(vii) Motivation. The program must of course be motivating and fun to use, though this consideration should be subject to the need for pedagogical integrity.

(viii) Pragmatics. It must run on the BBC micro computer.

It is interesting to note that few of these requirements have figured prominently (if at all) in any of the published Intelligent Tutoring Systems!

2 THE SUMIT INTELLIGENT ARITHMETIC TUTOR

The remainder of this article outlines the six year research programme that I have undertaken in order to meet the above requirements. The basic beliefs behind SUMIT were that it should look and feel the same as 'normal' sums while using the computer power to generate and store sums and answers, offering the immediate feedback of CAL plus the diagnostic and remedial ability of an ITS. In other words, the research was aimed at a synthesis of the traditional approach to teaching arithmetic with the ITS approach by producing a 'glass box' domain expert which followed precisely the traditional teaching progression but was able not only to offer correct advice to the user but also to diagnose and remedy the most common bugs. The research followed an 'evolutionary' strategy, where first a non-diagnostic program (SUMS) was developed and tested exhaustively in the school setting. The diagnostic capability was then 'grafted on' following futher research. The SUMS program is adequately documented elsewhere (ref 5, ref 6), and is freely available to British schools via the Council for Educational Technology. Consequently a brief history should suffice here, and I shall then concentrate on the final stages in the creation of SUMIT.

2.1 History of the SUMS program

The SUMS program was created jointly with my wife, Margaret K Nicolson, an experienced teacher of middle school arithmetic, and the collaboration involved extensive knowledge engineering studies undertaken over a period spanning three years in which:
(i) the traditional methods of teaching arithmetic were examined and a generalised teaching methodology was abstracted, involving the creation of ten 'grades' of difficulty for each operation, togther with rules for the generation of sums at each grade;
(ii) this expertise was then modelled in the form of the SUMS program, a generative semi-expert arithmetic tutor which was able to offer online and appropriate advice to the user (eg. "*You are trying to add the tens column, that is: 3 + 5 + 1 carry, so the result is 9*" and so on, but the help was non-diagnostic in that no effort was made to analyse errors.
(iii) the SUMS program was then extensively tested in the school environment, demonstrating in a formal controlled evaluation impressive improvements both in learning efficiency and in the understanding of arithmetic principles (ref 6).
(iv) SUMS was then made available for free publication by the Council for Technology via their SEMERCs. Informal enquiries at four regional centres indicate that the program has been welçomed for use over a wide range of abilities, including children with learning difficulties.

2.2 Adding 'Intelligence': the enhancement of SUMS to SUMIT

Early studies had shown that errors made using SUMS were qualitatively different from those reported by Brown and Burton, primarily because of the much more directive nature of the SUMS program - it forces the user to perform the necessary operations in the 'correct' order, and refuses to accept incorrect input. Consequently many bugs just cannot happen at all.

(i) Data Collection. In order to identify which bugs were the most common, SUMS was enhanced to present pre-stored pages of sums, and also to record the complete 'session log' on disc for subsequent analysis. This enhanced program was used to gather automatically a corpus of data relating to over 2000 addition and multiplication sums using 64 children from two Sheffield schools. A total of 1545 errors overall were recorded.
(ii) Bug analysis. The data were analysed by hand independently by two experimenters to identify the bugs involved. A total set of 19 bugs was identified for multiplication and 24 bugs for addition (based on a literature review plus analysis of the data). The bugs were then ranked in terms of frequency of occurrence - in fact 4 multiplication bugs and 9 addition bugs had zero occurrence.. Bugs with a frequency of greater than 2% are shown in Table 1.

TABLE 1. THE MOST FREQUENT BUGS FOR ADDITION AND MULTIPLICATION

Bug	% errors	Addition	Multiplication		
1A	32.8%	Forgets to add in carry	1M	23.4%	Puts down carry before digit
2A	24.9	Puts down carry before digit	2M	21.5	Forgets to add in carry
3A	13.0	Arithmetic error (eg. 6+2=9)	3M	20.1	Arithmetic error (eg. 6x7=48)
4A	6.1	Misses out one addend	4M	11.7	Unclassified
5A	5.1	Unclassified	5M	5.1	Extra column problem
6A	4.9	Carries at most 1	6M	3.8	*Add* digits in LH column
7A	3.1	Extra column problem	7M	3.0	0xN = N
8A	2.4	Carries 0	8M	2.8	0xN -> omit column
Total	92.3%			91.4%	

Notice that the percentage of errors classified is better for addition than multiplication (94.9% vs 88.3% respectively) and that for each operation the remaining set of 7 bugs was sufficient to account for over 80% of all errors made (over 90% of classifiable errors).
(iii) Bug diagnostic criterion. For each of the major bugs a diagnostic criterion plus appropriate remedial advice was identified, and this diagnostic capability was built into the program, thus producing the SUMIT (Sums Intelligent Tutor) suite. Interestingly, the enhancement of SUMS to create SUMIT produced a change of less than 1% in the overall program code.

3. DISCUSSION

3.1 Arithmetic Bugs

(i) Bug Catalogue. There is considerable consistency between operations. The two most common bugs are forgetting to add in a carry digit (eg. 35+46=71, 16x5=50) and putting down the carry digit *before* the answer digit (eg. for the units column in 36+27 the 1 is entered before the 3). Note that this is not a 'real' bug, merely a consequence of the consistent ordering required by SUMS. These two errors, plus arithmetic errors account for 65-70% of all errors. Bugs 5M and 7A (and possibly 6M) relate to a feature of the SUMS program - in a sum such as 54+62 where the answer goes into the hundreds column whereas the addends do not, SUMS required an explicit 'carry 1' to the hundreds, and then 'insert 1 in the answer row' (ie. 2 enter 1 operations), whereas the pencil-and-paper equivalent is to put the 1 straight into the answer row. I had thought this feature emphasised consistency but it obviously confused some users and has since been dropped! An example of 6M would be 16x3=26 where the user has merely added the 1 multiplicand to the 1 carry. The other bugs are fairly straightforward. Bug 4A refers to 3 row additions where the user 'forgets' a digit from one of the rows (eg. 3+4+5=7). Bug 6A refers to additions where the user does not grasp that carries sometimes should be greater than 1 (eg. 6+8+9=13). Note that this expectation follows from 2 row additions where the carry cannot exceed 1. The equivalent bug for multiplication was actually ninth in rank. Bugs 7M and 8M refer to multiplications where a multiplicand is 0 (eg. 20x3 = 63 for 7M and 20x3=6 for 8M).

(ii) Bug dominance. It is clear that a few major bugs account for almost all the errors. Interestingly this was also true for Brown and Burton's analysis of subtraction, for which 4 bugs accounted for 98% of the consistent errors made by their subjects. It is a tribute to their perseverance that they went on to identify 330 subtraction bugs, but surely they made the classic error of diminishing returns - more and more computation for less and less effect.

(iii) Bug Stability. One or two bugs were 'labile' in that they appeared and disappeared according to the context of the previous sum. This is the 'repair' phenomenon identified by Brown and Van Lehn (ref 4), in that users try faulty 'patches' to their existing rules but abandon them when they fail to give the correct answer consistently. The relative infrequency of this 'faulty repair' behaviour is no doubt a consequence of the immediate error feedback provided by SUMS, and it should be eliminated altogether by the targeted feedback provided by SUMIT.

(iv) Bug Remediation. For each operation only 5 bugs needed specific remediation over and above the standard display of the correct answer to that stage, in that 5A, 6M and 7M were eliminated via a change in the program. A simple reminder message (eg. 'remember to add in the carry 1' for 1A and 2M) has proved very effective in trials of SUMIT.

3.2 Implications for Intelligent Tutoring Systems

The key to the creation of SUMIT was, in the first place, the domain is well understood in procedural terms, and, crucially, we had access to a well-developed pedagogical model of how to proceed from the initial state of little knowledge to the desired state of full knowledge. The rest of the implementation - including the identification and diagnosis of bugs - was 'merely' an engineering exercise. If a teacher has a well-established method of teaching the topic in question, this should provide the starting point for the ITS. It is rash to divorce domain knowledge from pedagogic knowledge.

The approach adopted in SUMIT has an authoritarian feel - there is only one correct method to perform the operation, and the user is forced to follow it. There is good support for this approach from theoretical and empirical analyses of learning (see eg. Anderson, Boyle and Reiser, ref 7) but the strategy is probably only suitable for domains with a strong procedural emphasis.

The power of the SUMIT diagnostics depends crucially on the analysis of the incidence of different types of bugs. It would nothave been possible to predict the results of the survey in advance, owing to the uniqueform of instruction adopted.

The evolutionary development model adopted provides a sound methodology for the creation, within a reasonably short timespan, of useful programs which can subsequently be 'tuned' to the exact requirements of the learning environment.

REFERENCES

1. J R Hartley and D H Sleeman. Towards intelligent teaching systems. *Int. J. Man-Machine Studies*, **5**, 1973, 21[illegible]-236.
2. J S Brown and R R Burton. Diagnostic models for procedural bugs in basic mathematical skills. *Cognitive Science*, **2**, 1978, 155-192.
3. K Ruthven. The AI dimension? In D J Smith (ed) *IT and education: signposts and research directions*. ESRC London(1985).
4. J S Brown and K Van Lehn. RepairTheory: A generative theory of bugs in procedural skills. *Cognitive Science*, **4**, 1980, 379-426.
5. R I Nicolson and M K Nicolson. *SUMS - interactive middle school arithmetic*. Program suite distributed by Council for Educational Technology, (London 1984).
6. R I Nicolson, P Bowen and M K Ncolson. Classroom evaluation of the SUMS CAL arithmetic program. *Human Learning*, 3, 1984, 129-136.
7. J R Anderson, C F Boyle and BJ Reser. Intelligent Tutoring Systems. *Science*, **228**, 1985, 456-462.

A TUTORING AND DIAGNOSTIC SYSTEM FOR ARITHMETIC

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ABSTRACT

In this paper we present the outline of a Turbo Prolog program called **PCMATH**. The system offers a computerised diagnostic environment for ADDITION and SUBTRACTION which incorporates the knowledge of almost all known systematic bugs and number fact errors. **PCMATH** offers 3 levels of Exposition, Assistance and Test routines each of which is described. We conclude the paper with suggestions for future research and development.

INTRODUCTION

In this paper we shall describe a system called **PCMATH**, intended for use by pupils to improve their arithmetic skills.

The purpose of **PCMATH** is to provide pupils and teachers with a practical computerised diagnostic system for use within the classroom. It consists of two packages of modular design that provide remedial advice on ADDITION and SUBTRACTION on a personal computer. It incorporates some Artificial Intelligence (AI for short) concepts and and reasoning about the possible misconceptions of the pupil, as well as pointing out the pupil's errors.

The diagnostic philosophy for the system is based on determining what set of procedures give an incorrect answer to a particular problem. Therefore, the main idea underlying the design is a knowledge base encompassing almost all the possible systematic bugs as well as addition/subtraction number fact errors. **PCMATH** is not a copy of the text books or a picture of what the teacher is already doing. The environment of the arithmetic performance has been made almost similar to the natural environment of doing sums on a piece of paper.

The strategy for **PCMATH** is on three teaching levels:

[1] Exposition routine: attempted by DEMOSADD and DEMOSSUB programs.

[2] Carry/Borrow assistance routine: attempted by INTRACTA and INTRACTS programs.

[3] Test routine: attempted by ADDITION and SUBTRACTION programs.

The knowledge is represented internally as two databases: rules and messages. The structure enables a faster and more flexible response, matching the causes of error to the remedial message. Further clarification is provided by the system to give the exact location of the error.

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PCMATH uses the advanced graphics capabilities, seperate dialogue windows and animation techniques of TURBO PROLOG running on an IBM XT or IBM AT, giving a friendly and comprehensive user interface. Therefore, pupils can interact easily with a microcomputer. Further, it provides for the teacher an insight into the pupil's cognitive processes in carring out simple arithmetic operations.

PCMATH ARCHITECTURE

The system grew from the area of Computer Aided Learning. It deals fundamentally with arithmetic, teaching as well as pointing out the pupil's errors.

According to Brown and Burton 1978 (ref 1),"children make errors because they have faulty versions of certain components of the skill. Their view regards the skill in terms of an algorithm for performing subtraction (subtraction is used as a paradigmatic case for studing diagnosis)".

According to production systems (or PSs for short),"the errors are made primarily because certain components are missing. So PS analysis instead sees the skill as a more anarchic structure, made up from a collection of independent pieces each representing a chunk of codified local knowledge the child has about how to subtract" (ref 2).

PROLOG was used in preference to a 'sequential' language (e.g Pascal, C, etc.), since conceptually our implementation is rule based, and the advanced pattern matching capabilities of PROLOG free the program from such technical considerations. Further, since TURBO PROLOG, in fact, runs compiled, execution time is not unacceptable.

The strategy for **PCMATH** is on three teaching levels:

[1] **Exposition routine:** This routine demonstrates to the user the addition/subtraction operations at a speed that clearly shows each step in the operation.

Windows, sound and colour graphics have proved extremely useful. Therefore, several windows are used at the same time. Each of them has a specific function. For example the Drill window is responsible for demonstrating the exercise at the top of the main screen. No process runs in this window. It waits until the answer is transferred from the Processing window. At the same time, processing appears underneath the Drill window. Inside this window, the exercise which has already appeared in the Drill window will be executed.

Then processing is demonstrated step by step starting from the unit's column the ten's column etc. and whenever there is a 'carry' or a 'borrow' this program, simply and clearly, shows the user how to deal with it (i.e. In this case, a '1' will be printed on the screen in the appropriate place to denote the carried digit). When the answer is complete, it will be transferred to the appropriate position in the Drill window.

[2] **Assistance routine:** One feature of this program is that it supports a 'carry' or a 'borrow' automaticaly whenever it is needed. So the user

will need only to type the sum for each column regardless of whether there is a carry, because the program does the carry. Therefore the user starts working out the answer at the right-most column, i.e. unit's column first, and then moves left to the ten's column until the answer is complete. which is how one would do it with pencil and paper.

Each column's answer is checked step by step. If the answer is correct in the current column the cursor will move to the appropriate position to receive the answer for next column to the left. Whenever there is an incorrect answer, a specific Error window will appear underneath the incorrect answer corresponding to that error, allowing the user either to retype the answer if the user chooses option 'r' or to see the processing for this current column if the user chooses option 'h'.

[3] **ADDITION routine**: This routine is very important, since it tells the user what he has done wrong and informs him of the possible causes of the errors. Also, an important feature of the routine is that it allows the user to type his answer from right to left, which is how one would approach the problem with pencil and paper.

When the answer is complete, the program starts checking the answer. If the answer is correct, it will be transferred to the appropriate position in the Drill window. Another window (the Report window) will appear in the middle of the screen giving appropriate messages referring to the correct answer. However, if the answer is wrong, another window will appear underneath the answer (called the Possible Causes Error) inside this window, a menu gives three choices :

[1] If the user chooses 'r', the routine gives him another chance to attempt the answer starting from the right most column after clearing the previous answer.

[2] If he chooses 'd', the routine calls the exposition routine to provide the user with a demonstration for the current drill. This demonstration is slowed down to show clearly each step in the addition process.

[3] However, if he chooses 'h', the routine calls the BUGS CATALOGUE routine. This routine diagnoses all the systematic errors known. The routine analyses and compares the user's answer with the correct answer. The BUGS CATALOGUE routine has been supported by several programs following different strategies.

CONCLUSIONS

PCMATH system is built as a practical computerised diagnostic system similar to the natural environment of pen and paper. The system knows about almost all possible systematic bugs as well as number fact errors for addition and subtraction. The system consists of 3 levels of exposition, assistance and test routines.

We propose to use PCMATH on its own and in conjunction with worksheets and blank (column & line) paper. We would encourage the children to use the routine to assist their arithmetic work, where the sums are part of wider projects (e.g. designing lay-outs, constructing objects, measurements, experiments, etc...).

We would also use the routine for specific attempts to tackle carry/borrow problems. After they had had an opportunity to play with the package and become familiar with its workings, we would introduce the use of the paper worksheets. The purpose of these work sheets would be to allow the children time to follow the "borrow 10/decrement left column" or "carry 10/increment left column" process which is done for them. The first worksheet would show them how to replicate on paper what the computer does. For example, the sum 530 - 253, would be input to the computer and recorded on paper as:

$$\begin{array}{rccc} & 4 & 12 & 10 \\ & \cancel{5} & \cancel{3} & \cancel{0} \\ - & & & \\ & 2 & 5 & 3 \\ \hline & 2 & 7 & 7 \end{array}$$

Also the routine would give pupils further advantages such as:

[1] They would choose their own sums, input them on the computer and record them on paper. Then, as they step through the sum they would try to correctly up-date the sum with the appropriate scratch marks on the worksheet paper.

[2] They could compare their group's sums and scratch marks with other groups' sums.

[3] They would tackle worksheets of prescribed sums by the teacher. These could then be viewed by the teacher and typical bugs spotted. The children could then enter the buggy answers and their original sum by presenting them to the third program, in order to see if it spots the error. This seems a nice use of the "test routine" as it means a debug problem rather than classification of student competence.

We belive that the ideas incorporated in the PCMATH system are novel enough for serious evaluation we plan to extend the system to cover multiplication and division in the near future. We also plan to present a workable curriculum for the teaching of basic arithmetic skill based around PCMATH as the final stage of our project.

ACKNOWLEDGEMENTS

I would like to thank my supervisor, Masoud Yazdani, for his invaluable support throughout this project. This work was supported by a studentship from the government of Iraq.

REFERENCES

1. Brown, J. S. and Burton, R. R. (1978). "Diagnostic models for procedural bugs in basic mathematical skills", Cognitive science, 2, pp. 155-192.

2. Young, R.M. and O'Shea, T. (1981). "Errors in Children's Subtraction", Cognitive science, Vol. 5, pp. 153-176.

SMALLTALK AS A VEHICLE FOR INTELLIGENT COMPUTER ASSISTED LEARNING

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ABSTRACT

We are currently using Smalltalk as a means of implementing an Intelligent CAL system to help children perform the transition from an initial mathematical problem statement to a solution in the form of a program. The approach is necessarily strongly knowledge-based. Smalltalk has had great claims made for it. In this paper we report on how difficult it has been to get the Smalltalk system to do what we wanted. Furthermore, we describe the influence that Smalltalk itself has had on our trial version of the product, and how children reacted to it. We attempt to give some guidelines as to whether Smalltalk is a suitable choice for such an application.

INTRODUCTION

We are developing a programming language called Plogo, which initially derived its inspiration from LOGO (ref 1). Whereas LOGO has particular applicability to the domain of plane geometry, Plogo is intended to make number theory more accessible to children. Plogo involves controlling 'planes' (aeroplanes) which visit 'islands' laid out as a number grid. Later we introduced some of the concepts of programming by constraints (ref 2). In addition to this, we are in the process of adding an expert system to the Plogo environment. We desire to give computer-based help to children with misconceptions, programming bugs, and other problems inevitably encountered in using Plogo.

We have chosen Smalltalk as an implementation vehicle, since it is claimed that this language is appropriate for a wide range of applications. Its use is advocated for exploratory programming (ref 3) and educational applications (ref 4). It has been urged as 'An emerging language for expert systems and AI work' (ref 5). Thus we inferred that it may be suitable for our purposes.

WHAT IS SMALLTALK?

Smalltalk is an 'object-oriented' programming language, which normally runs on a relatively expensive workstation, such as a SUN. (We are mostly using a purpose-built Tektronix 4404 for our Smalltalk projects).

A 'Top-Down' approach is often taken in system development. This approach involves decomposing a system into manageable procedures. In contrast, an 'Object-Oriented' approach involves decomposing a complex system into a set of self-contained **objects**. One obvious application of objects is in a genuine simulation. For example, a simulation of an engine may include objects representing pistons, valves and spark plugs.

These objects can send **messages** to each other: the programmer decides the behaviour of an object receiving a message by defining a **method** for the **class** of object of which it is an **instance**. There is an hierarchy of classes. Anything defined in a class applies to its subclasses too, except when the definition is overridden. A library of classes is provided as an essential part of the Smalltalk environment (in fact, most of the features of the Smalltalk environment are programmed in Smalltalk itself). Any new classes are added into the existing hierarchy of classes, wherever the programmer feels is most appropriate.

Smalltalk is much more than a programming language, however. It is a complete development environment, which is totally unseparated from the run-time system. The programmer is provided with a window-based system with mouse-driven interaction. Tools exist for modifying and creating classes, inspecting objects, typing in expressions, debugging, and many other functions.

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LEARNING SMALLTALK

One of the major problems a potential Smalltalk programmer encounters is that it takes quite a long time before one feels that one has acquired any Smalltalk ability at all. A Basic programmer could normally start writing elementary programs in Pascal after only a limited time spent learning the language. However, in our early days with the Smalltalk system it seemed as if we were not getting anywhere at all. We certainly understood the *syntax* of the language, but this is one of the easiest aspects of learning Smalltalk. Learning to use the tools provided for system development is not very difficult either. We identify the main difficulties as:

(1) The fact that, for us at least, the available documentation was unsuitable for self-teaching.

(2) The conceptual difficulty that *everything* in the Smalltalk system is an object, even an integer.

(3) Learning the basic functions of the large library of classes provided.

(4) The fact that virtually any Smalltalk application will include some kind of user interface. Thus, it is not possible to develop an application easily until the classes provided by Smalltalk which concern user interfaces are mastered. Moreover, the documentation on this aspect of Smalltalk is particularly lacking. It is possible to design a user interface by just writing all the code oneself, but we realized that this would involve a large amount of wasted programmer effort.

Learning the *basic* functions of the classes provided is essential. To know the details is not. What is needed is to have an overall mental 'map' of the class hierarchy. This is essential so that we can quickly ascertain roughly where our application's classes should fit into the existing structure. Moreover, the existing class structure may actually help us to decide on the decomposition of an application into objects.

Thus we have found that a large amount of investment of effort is required before any useful applications emerge. However, we have found that once this initial grasp of the system has been obtained, quick progress is made, and the dismay felt initially gives way to temporary elation. This elation is subdued as one starts developing real applications: inevitably, Smalltalk has its faults.

DEVELOPING SOFTWARE

It has sometimes proved difficult to decompose a problem into objects. In fact, this tends to be the most difficult single activity when developing an application; it is also time-consuming. Attempts have been made to formulate the elements of good object-oriented design: however, the general attitude is that a decomposition of objects should be produced which is *intuitively* pleasing. Indeed, this is one of the problems encountered by a learner of Smalltalk. He or she does not know when a good piece of Smalltalk code has been achieved. Sometimes there is an obvious decomposition, especially where one is representing some real-life system (as in the engine simulation mentioned earlier). At other times it is necessary to make some kind of artificial (but hopefully reasonable) decomposition.

It is necessary to decide where the new objects fit into the existing system. Sometimes when defining a new class, we have found that there is no existing class which really relates to it: then we have to do most of the work on implementation ourselves. At other times, there is some class which almost does what we want, and we can simply create a new subclass, re-define a few messages in that subclass, and the new class definition is completed with a minimal amount of effort.

Unfortunately, there are cases where a class seems to be useful, but there are difficulties of implementation which mean that subclassing is not economical. An example is our experience with developing a Plogo interpreter. We decided not to use most of the existing Smalltalk compiler classes simply because they were implemented in a way which we regarded as too specific to the Smalltalk language itself. Perhaps we could have used those classes and thus made a bad decision. Nevertheless our decision should indicate the complexities which we would have encountered when performing what seemed like a natural subclassing activity.

The Smalltalk environment is very conducive to interactive programming (as suggested by the title of one of the books (ref 6)). New Smalltalk applications can often be written without recourse to pen and paper. The browsers and other tools allow the programmer to see different methods on the screen at the same time, along with other relevant information. This often helps in the design of a new method. A 'hacking' approach such as this has obvious pitfalls, nonetheless. One goal of object-oriented design is enhanced software reusability (ref 7). To succeed in doing this requires careful planning, and certainly 'hacking' must be avoided if reuse is a major consideration. However, we have been programming in an exploratory fashion, and so we have not really had any detailed design specification to work towards. This means that knowing how to design our classes for reuse is difficult anyway: we do not know what reuse we shall desire. What is necessary for us is to be able to put together a prototype rapidly. We have often found Smalltalk well-suited to this need. It is sometimes more sensible to do quite substantial re-implementation if we find that we are dissatisfied with our application. But Smalltalk does support quick, relatively effortless 'hacking', and is reasonably adept at allowing a more rigorous software-engineered approach to programming.

Some people find it very useful to be able to put together a kind of framework for an application, and then fill in the details later. In Smalltalk, this approach is well-supported. The first steps are to define the basic objects of an application and to formulate the way that they interact. A rough prototype can then be developed. In the prototype, objects may not do much in response to certain messages, but a distinct framework exists which is useful for the attention to particulars which must follow.

When one has typed in the appropriate code, it is possible (essential, in fact) to make a 'snapshot' of one's work. This saves the current state of the Smalltalk environment on the disk. Then, if a serious crash occurs while running the new software, it is possible to get the uncorrupted environment back by just re-loading it. There is a debugger which allows the programmer to access much information about the running of a program in a convenient form. It is often possible to find programming bugs very quickly using this tool.

One major problem which we have come across is that there are bugs in the Smalltalk system. One of the most irritating ones was a bug in the text editor which, while we found it bearable, would be unacceptable in a system for use by young children. In this case, we fixed the bug. But the point is, that if we are to reuse the system classes in any way, they must be bug-free, reliable implementations.

INFLUENCE OF SMALLTALK ON OUR DESIGN

Our choice of Smalltalk has had some significant effects with respect to the design of the Plogo system. We have at our disposal a machine capable of displaying high resolution (black & white) bit-mapped images. Thus pictures, diagrams and 'icons' may be displayed. Window-management, text editors, various kinds of menus, and many other features are provided by the system. We have used all these, yielding an environment which children should find easy to comprehend. In many cases, we have created subclasses which are simplified versions of the tools provided by the system. For example, our text editor is much simpler than the standard Smalltalk offering.

We have had difficulty in deciding how to implement an expert system in Smalltalk. Briefly, the problem is that although we could implement any conventional kind of expert system shell without too much difficulty, we feel that to resort to a *shell* is contrary to the spirit of Smalltalk. For our particular application, we are proceeding by just using normal object-oriented programming for the knowledge-based aspect of our work too. This is somewhat like a Frame-based expert system approach, with no explicit rule-based component.

OTHER CONSIDERATIONS

One major criticism which is frequently made of Smalltalk is that of hardware requirements and inefficiency of implementation. The cheapest full Smalltalk implementation is currently for an AT-compatible (such as an Opus) with 640K of base memory, 512K of expansion memory, a serial mouse and an EGA card. Smalltalk requires fast hardware to run at an acceptable speed. We have found our Tektronix 4404 just about adequate (this is faster than the AT version). It is often possible to significantly optimize a time-critical application. One major restriction of many implementations is upon the number of objects which may exist in the system. The Tektronix 4404 allows 32K objects, which is barely adequate for a serious application.

CONCLUSIONS

It is difficult to convey what it is like to use the Smalltalk system (other than by enthusicstic description). Our enthusiasm is due both to the concept of object-oriented programming and to the tools provided for development of applications. Once one has become acquainted with the Smalltalk system, it is possible to do most things with relative ease. We feel that there are two major problems. The one is simply learning to program in Smalltalk. Hybrid languages (where objects are only used if and when they are deemed appropriate) often facilitate a smoother transition to object-oriented programming (e.g. ref 8). We would advise against learning Smalltalk unless one is willing to expend considerable time and effort (perhaps a year) before worthwhile results can be achieved. The other problem is basically an implementational one. There are bugs, shortcomings in the development tools, and speed problems. We propose that Smalltalk needs to be re-implemented, and somewhat re-designed. In fact, there *is* a re-implementation of Smalltalk which will run on a relatively standard IBM PC: Smalltalk-V (Supplied in this country by Smalltalk Express Ltd.). We are not really familiar with it, but it seems that some of the efficiency problems are reduced. Also, the basic Smalltalk-V system uses perhaps half as many objects as the standard system. Regrettably they achieve this at least partially by providing a somewhat scaled-down system. Speed is becoming less of a problem as powerful machines become cheaper. However, at present the expensive hardware required still limits Smalltalk's distribution.

The most fundamental (and probably persistent) problem is the *learnability* of Smalltalk. We have found the existing documentation unsuitable. Perhaps we shall find eventually that books are produced which are more usable for self-teaching. One book that gives a reasonable introduction at just a very elementary level is 'A Taste Of Smalltalk' (ref 9). However, we have not found books that are much help for progressing beyond this starting point. One is basically left to one's own devices.

Thus we are quite happy to continue using Smalltalk ourselves: it is a useful tool, and reasonably suitable for what we wish to do. But we would warn prospective users of Smalltalk that a sizeable effort is required to learn it. This may be found to be disproportionate to the benefit incurred.

REFERENCES

1. S. Papert, Mindstorms (Harvester Press, Brighton, 1980).
2. J. Jaffar & J.-L. Lassez, 'Constraint Logic Programming', Proceedings of the Conference on Principles of Programming Languages, Munich, 1987.
3. J. Diedrich & J. Milton, 'Experimental Prototyping in Smalltalk', IEEE Software, May 1987.
4. W. Finzer & L. Gould, 'Programming By Rehearsal', Byte, June 1984.
5. J.H. Alexander & M.J. Freiling, 'Smalltalk-80 aids troubleshooting system development', Systems & Software, April 1985.
6. A. Goldberg, Smalltalk-80: The Interactive Programming Environment (Addison-Wesley, Reading, Ma., 1984).
7. B. Cox, Object-Oriented Programming: An Evolutionary Approach (Addison-Wesley, Reading, Ma., 1986) p. iv (preface).
8. K.J. Schmucker, Object-Oriented Programming for the Macintosh (Hayden Book Company, New Jersey, 1986) p. 38.
9. T. Kaehler & D. Patterson, A Taste of Smalltalk (W.W. Norton, NY, 1986).

THE DEVELOPMENT OF INSTRUCTOR-ORIENTED MATERIALS FOR INSTRUCTION IN COMPUTER CONCEPTS

Bell, Norman T.[1]

ABSTRACT

In an effort to improve the teaching and learning of computer-related concepts, an instructional system has been designed which includes certain components which are important to the students and the teachers. Five such components have been included in modules designed for the teaching of computer-related concepts. Further, in this instructional system, specific components for instructor assistance have been designed to allow the instructor to have a type of "on-line" help available during the presentation of concepts to the students. Initial findings from studies conducted on the use of this system have indicated that both teachers and learners find the system to be helpful, and that with the addition of certain other components to the original five, the system has proved to be most effective with a wide range of students. With the continuing availability of computer applications programs which must be taught to students, this teaching system will continue to be useful in teaching computer concepts.

INTRODUCTION

With the introduction of the computer in the school curriculum, it became evident that there was a need for materials specifically designed to teach students concepts related to the use of these computers. Initially it appeared that the well-established publishing houses would follow the usual pattern of developing books about computers, and indeed many such books were introduced. A review of typical texts indicates that most such books appear to be written for individuals who know far more about computers than most of the teachers for whom the books were developed. As a consequence, there began to appear in the popular computer journals, series of articles aimed at a much lower level of computer expertise, and therefore far more useful to teachers and students. Many of these articles were copied from the journals and distributed to the students. Yet there was a need for an alternative approach to the development of computer-related curricular materials.

A NEW APPROACH TO COMPUTER INSTRUCTION

Because teachers were being asked to present concepts about which they themselves had never had any formal training, a radically different type of materials was needed. Thus, to assist the teachers in their presentations of computer-related concepts, a series of highly-structured materials were developed which provided assistance to the teacher while the concepts were being presented. Such an approach was designed to parallel the "on-line" helps which have become so popular in providing assistance to the user of computer applications. Such help is available at all times, is displayed only when desired, and is referred to less and less as the user becomes proficient. In a similar fashion these teacher helps are available at all times to the computer teachers, and as the teachers become proficient in this subject matter area, such helps are referred to less and less.

COMPONENTS OF INSTRUCTOR-ORIENTED MATERIALS

This highly structured approach has a number of important components. At the outset, each module has structured in it the information needed by students to answer important motivational questions. For example, each module begins with an *Overview*, designed to answer the question often asked by students, "What is this lesson all about?" Immediately following there is the presentation of the *Objectives*, designed to answer the question, "What will I be able to do when I master this lesson?" Thus, these components are used to orient the students both to the behavior of the teacher, as well as their own behavior.

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Once these preliminary motivational questions are answered, the next component of every module, the *Structured Notes* , is implemented. It has been noted that when students face a new subject matter area, they often don't seem to know where to start in recording information in their class notes. Consequently, the approach used in the development of these modules provide the students help in the form of partially completed notes. Such notes are designed to help the student answer the question, "What really are the important points being presented in this lesson?" Sometimes the information completed by the students will be the completion of statements concerning methods of computer operation. For example, there may be five steps which must be followed in saving a file, and it may be that in the student notes there are five numbered blank lines which are vertically arranged, and as the instructor explains each step, the students record these steps in their notes, and then later refer to these notes as they operate the computers. In effect, the students are completing their own reference manuals.

Immediately following the presentation of the content , the next component of this structured approach, the *Quick Quiz,* is implemented. Quizzes are used to help the students answer the question, "How well have I mastered this lesson?" Such a quiz can be presented either using paper and pencil, accompanied by an immediate feedback device, or can be presented using the computer. Since the results of such quizzes are not included in the computation of the final course grades, such quizzes are presented in a non-threatening environment.

Following the quiz, the students are presented with a hands-on *Activity* which is designed to help them answer the question, "Can I apply what I have learned in this lesson?" Unless the students are given the opportunity to apply what is learned, they will never know how successful they have been in learning the concepts. In teaching computer concepts, real benefits come from the fact that the students do not have to wait days or weeks to determine if they can use what they have learned. Every time they sit down at the computer, they are able to check on the quality of their learning. In addition, because of the very nature of the computer, this crucial feedback concerning the degree of accuracy of the learning is provided by the computer.

STRUCTURING MODULE CONTENT

With the content identified, the module designer must determine the order of presentation of the concepts. There are two methods which have proved to be useful in determining how to structure the content of the modules. The first of these methods is called RULEG. The first four letters of this term make up the word "rule" and indicate a rule concerning computer operation is to be presented by the instructor. For example, in teaching in BASIC how the contents of certain locations of computer memory can be displayed on the monitor, the instructor can explain the use of the PRINT statement by stating the relevant rule. The last two letters of RULEG, the "EG" portion, indicate that the statement of the rule will be followed by examples (E.G.) of the use of the rule. Consequently the instructor can demonstrate several examples of the use of the PRINT statement. Thus, RULEG begins with the statement of the rule and is followed by a series of examples which illustrate the use of the rule.

The second structuring method is the reverse of RULEG and is termed EGRULE. From its name it is obvious that a set of examples is first to be presented, and then the rule is to be determined from a study of such examples. Consequently, the EGRULE approach in teaching the use of the PRINT statement would logically be the display of a series of applications of the statement in which the input and the output are displayed and can be compared. Following the study of the examples, the students are then asked to state the rule which relates output to input. This approach has often been called "discovery learning" and is especially suited to computer-related instruction since the computer can so easily be used as the generator of the EG's and an unlimited number can be produced.

In the structuring of the content, these two methods were combined with another technique, termed Mathetics. Inherent in this method is the goal of providing enough support for the students so they will have a maximum of success. For example, in using mathetics in teaching word processing, rather than having the students create a document from scratch and then make changes to the document, the document would previously have been created and would be contained on diskettes distributed to the students, and the students would merely load the document and then make indicated changes. Thus the details related to creating the document would be taught after the students have had success in manipulating the document by inserting, deleting, and exchanging text information. In using the mathetics approach in teaching BASIC, the students are provided with a library of subroutines and shown how to call these as needed in their program. Thus the details of the programming in the subroutines can be taught some time after the students have learned to use subroutines. Although these various methods were used throughout the modules, as the lessons progressed there was a definite shift from RULEG to EGRULE and an increase in the use of Mathetics.

INSTRUCTOR MATERIALS

Special effort was placed on the design of materials to provide a type of "on-line" assistance to the instructors. All the modules had as the major presentational device the overhead projector with transparencies produced for use by the teachers. The transparencies were three-hole punched and stored in three-ring notebooks. The transparencies were slit from the three holes to the margin so that they could easily be pulled from the notebook with no need for opening the rings of the notebook. As soon as the information contained on an individual transparency was presented, the transparency was "popped" back into the notebook, again without opening the rings. Thus, at the completion of the lesson, the transparencies were stored in correct order, and ready for subsequent use. During the presentation, the instructor would add written information to the transparency. Such information would also be recorded by the students in the Structured Notes portion of their materials. Consequently, there was missing information on the transparencies, corresponding to the missing information in the Structured Notes. For assistance to the instructor, there were paper copies of the transparencies in the Instructor Guide with all the information "filled-in." This method proved to be extremely helpful to the instructors, especially those new to the computers.

SUMMARY OF FINDINGS RELATED TO INITIAL USE OF MATERIALS

In one study of the use of such materials with elementary students, several interesting findings resulted. To determine effect of the materials on learning and attitude toward computers, two pre-measures were used. The first related to the content of the module and consisted of a series of multiple-choice questions. The second was a questionnaire directed at determining change in attitude toward computers and computing. Post-measures were also developed which were parallel in form and content. With respect to content learning, significant differences were found between the pre- and the post-measure scores. With regard to the attitude changes, a most interesting finding related to two questions concerning a factor related to who could use computers. When asked whether or not only bright individuals could use computers, both on the before-the-experience and after-the-experience measure, the students strongly agreed that only bright individuals could use computers. However, when asked whether or not they themselves could use computers, on the pre-measure the students strongly disagreed, but following the lessons the response was "strongly agree." Thus it appears that there may have been some change in self-concept related to computing. It appears that after the lesson the students felt that they should be included in that set of individuals referred to as bright.

An additional set of findings concerning the use of this instructional approach indicated that regardless of age or experience of the learner, the materials seemed to provide the help both the instructors and the students needed. Materials produced using this method of design have been tested with students ranging from middle elementary to post-doctoral and it appears that only minor adjustments are needed to allow success throughout this wide range of age and experience.

SUMMARY

With computers becoming more and more available in the schools, and with the continuing increase in the availability of new computer application programs, such instructional methods will continue to be needed for teachers and students. Efforts are continuing to be directed at designing and testing materials which are useful by teachers with little or no experience in their tasks related to teaching about computers. The findings related to the use of these structured materials have been encouraging to the designer, and currently there are additions being made to the components of the structured modules. For example, following the presentation of the Overview and the Objectives, each module now has built in to it a Review, to answer the question, "What do I have to remember to be successful with this new lesson?" Also, after the presentation of the new material and prior to the Quick Quiz, each module now has a Summary section to answer the question, "What were the key points in this lesson?" Further studies are being conducted to determine what it is that the students should be recording in their class notes, whether it is more important to record the rules, or the outcome of applying the rules. Throughout the experience with this method, it does appear that the increase in the degree of structure is not offensive to teachers or students, and that the amount of assistance provided to teachers is acceptable to both new and experienced teachers. With such feedback, the development of additional lessons and the continued effort at improving the system will continue.

CORE MATERIAL FOR RETRAINING SECONDARY TEACHERS TO TEACH COMPUTER SCIENCE[#]

Robert M. Aiken[*]

ABSTRACT

What different school systems consider sufficient material for retraining experienced secondary school teachers to teach pre-College Computer Science varies a great deal. This paper discusses one retraining model, based in part on curricula recommendations for computer science for secondary school students published by the Association for Computing Machinery's (ACM) Elementary and Secondary School Committee. (ref. 1) Emphasis in this paper is placed on what material was covered, especially what constitutes the minimum core. Observations are also included with respect to factors influencing the success of the participants in this program and aspects that others designing similar programs should consider. Analysis of data from pre and post test evaluations is also discussed.

INTRODUCTION

The need for teachers of computer science at the secondary school level has been recognized for several years. It is obvious that the critical need which we face today can not be entirely satisfied by graduates from teacher training colleges.

First, too few such colleges offer computer science education programs and, second, those colleges which do offer such programs are producing too few teachers to fill available slots. Not surprisingly, a major means of obtaining computer science teachers is through retraining of experienced teachers who have backgrounds in other subjects. This retraining is accomplished in several ways, including in-service workshops and training programs within school systems and special courses and programs offered at various colleges and universities. In order to help meet the demand for teachers of Computer Science the author, working with several colleagues, conducted a project entitled, "Development of a Model Program for Preparing Computer Science Teachers at the Secondary School Level".

WHAT CONSTITUTES THE CORE MATERIAL?

A few course descriptions and syllabi (like the ACM model we adapted) were available when we proposed this project in early 1985. However, to the best of our knowledge this was the first attempt to develop and test a model for retraining teachers to teach this material. Thus, our goal was to extrapolate from the descriptions of secondary school computer science courses a coherent set of courses that would serve as a minimum, core curriculum for retraining teachers who would be teaching computer

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[#] This research has been supported in part by a National Science Foundation Grant, TEI-8550553.

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science. We decided that three computer science courses and one instructional design course would constitute the core material.

As a major part of the project, two groups (28 per group) of experienced teachers took as a first course, problem solving with Applesoft BASIC (since Apple systems are available in the schools and BASIC is the first language taught), a second course on problem solving using Pascal, a third on advanced Pascal programming and an introduction to data structures, and a fourth on instructional design. This fourth course was a practicum in which participants applied the concepts learned in the first three courses to develop course materials and teaching strategems for Computer Science. Additional details about this project are provided in Epstein, et al. (ref.2)

Having recently completed the program and having talked with the first group of participants who have been teaching Computer Science since September 1987, it seems that this program did not provide enough computer science material. Even though students finishing in the top half of the class were able to pass the Computer Science teacher competency exam administered by the Philadelphia School District, they did not have enough background in topics such as advanced data structures and machine organization to feel confident about teaching advanced material at the secondary level. Perhaps this isn't surprising when we realize that teachers in most areas have several years of study in their chosen field-not just three courses.

Based on my recent experience I would say that the minimum, core component would consist of five Computer Science courses, three such as the ones we included in our program that emphasize the fundamentals of Computer Science and Problem Solving using at least two different languages, plus a course in advanced data structures, and one covering the basic notions of machine organization. The courses must be carefully crafted so they build on one another, avoiding unnecessary duplication and using previous ideas and examples to introduce new concepts. The courses need to provide both depth and breadth. They must not be beginning level programming courses but should proceed in a logical sequence to build a good foundation. If possible graduate level credit should be given for the coursework.

There is independent support for this position. A final draft of a report, "Retraining Teachers to Teach High School Computer Science", is in preparation by an ACM Task Force.(ref.3) This report recommends six Computer Science courses as a minimum: Fundamental Computer Science for Teachers, Advanced Data Structures, Programming Languages for Educators, Machine Organization, and two electives from a list that includes Computer Assisted Instruction, Artificial Intelligence, Graphics, Human Factors, etc.

Whatever program is adopted it is clear that anyone teaching Computer Science must have a solid foundation in the principles, as well as ample time to apply these principles in a laboratory. Teachers must be given the time and resources to be retrained properly. To do otherwise will only lead to a further inability to educate our students in this dynamic and fascinating discipline.

ADDITIONAL OBSERVATIONS ABOUT THE RETRAINING PROJECT

A complete summary of the results is not available since not all the data has been analyzed. However, the following points represent some of the major findings to-date.

1. Students doing well in our program have received sufficient background to teach Computer Science courses in Secondary Schools as measured by their performance on an independent test administered by the Office of Computer Science Technology - School District of Philadelphia. (Though even the best students feel they need additional computer science background in order to feel more confident about teaching.)
2. The students benefitted most from group projects. The sharing of information and the social interactions definitely appealed to them.
3. Being able to borrow computers from the school to work on assignments at home is a big advantage. Thus performance on courses taken during the Summer when this was possible was better than courses taken during the school year.
4. Using fellow teachers as assistants in the computing laboratory works well. We had success with using graduates from the first group as assistants in the advanced Pascal/data structures course for the second group.
5. Teachers without prior computing experience and with poor mathematics backgrounds can succeed, but only with tremendous effort and ready access to a computer.

Based on pre-and post tests we have also learned:

6. Students who had actually written programs in previous computer coursework performed better than their colleagues who had only learned about the computer (or those without any prior exposure).
7. A solid mathematics background definitely was a help but it was not as good a predictor of success as was computer experience.
8. Initial results suggest that personal attributes (computer technology aptitudes, literacy, interest, and attitudes and expectations) could be highly predictive of academic achievement in this program.
9. Students generally expected to learn more from the program than it was designed to deliver.
10. Students expectations influenced their evaluation of the program with those having the most realistic expectations being the most satisfied.

Three other general observations should be emphasized. First, one of the keys to the success of the program was the strong support given to it by the Computer Science group at the Philadelphia School District. Their willingness to assist in a number of different ways - from helping to design the model to participating as guest lecturers - made the program much more meaningful to the students. Second, the 56 participants were selected from more than 320 who applied. The major factor used in selecting them was motivation - did the applicant appear to be motivated enough to complete four tough courses in addition to their teaching load Though the participants did receive twelve graduate credits and a $500 stipend, this was a small reward for all the effort they expended to finish the program. We had been told that we would be fortunate if even half of the original group completed the program, so we were pleased that over 70% finished (41 out of the 56). Finally, it should be noted that the success of any program like this will be affected by aspects outside the control of the project directors. For instance, the number of positions that were eventually available to our graduates were less than the number initially anticipated due to financial and other considerations within the school district (though an increase is expected in the next fiscal year).

CONCLUSION

The model we used or the model proposed by the ACM Task Force on Retraining may not be the "right" model for everyone. That's not important. What is important is that models like these be developed, tested and disseminated. There is a recognized need for retraining programs, and the more evidence we can obtain on what works and what doesn't, the easier it will be to develop programs that will do an effective job of retraining teachers to teach computer science.

REFERENCES

1. J. Rogers, R. Aiken, et. al. CACM, March, 1985, p. 270.
2. R. Epstein, R. Aiken, et. al., ACM-SIGCSE Technical Symposium, v. 19, p. 136, 1987.
3. J. L. Poirot, et. al., Draft Report, Private Communication, Dec., 1987.

A FIVE-STAGE MODEL FOR INTEGRATION OF MICROCOMPUTERS IN TEACHER EDUCATION

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ABSTRACT

It has been a major problem in the United States to integrate microcomputers into the curriculum of Teacher Education programs in Schools and Colleges of Education. Phobias, resistance to change, lack of funding, lack of training, and unavailable or poor quality software have been some of the reasons for the difficulty. This paper succinctly examines the stages which often occur in the development of micro programs in higher education highlighting the staff development activities, computer-assisted instruction/ computer-managed instruction tasks, evaluation needs, and hardware/software requirements. In addition, guidelines for implementing a staff development program will be emphasized.

INTRODUCTION

Various surveys have indicated a widespread tendency by Schools of Education to include as a requirement in the basic education curriculum a computer literacy course. This trend has been precipitated by state-mandated computer literacy requirements as part of the certification process. Based upon a recent federal government survey (ref 1), fifty percent of all schools offer a course or component in computer literacy to undergraduates. With current growth in this area, ninety percent of all Schools of Education will require a basic computer course in a few years.

Professors of educational computing are promoting the micro as a useful tool for use by all members of society. Logically, other faculty ought to mirror their micro activities for students to emulate. In most cases faculty in the schools of Education are not prime users of high technology. Historically, most of them never frequented the campus computer center, never requested mainframe operating time, and never owned a personal computer. On many campuses, computer literacy should be required for faculty, as well as students. However, in many cases educators do have some distinct drawbacks.

Cory (ref 2) indicated that introducing microcomputers into the curriculum is a unique change for educators. For example, few, if any, of their professors were trained to use computers. In addition, there is no historical precedent with many prototypes from which educators could select a plan for their own school. He also indicated that usually at the beginning there is not enough money to purchase complete systems for maximum utilization. Teachers have also had poor training in the use of basic instructional technology. In many states it is not required or presented in modular fashion without much substance or impact.

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Despite the problems involved in integrating micros in the schools of Education, microcomputer use can precipitate major dividends. For example, Gray (ref 3) outlined four faculty uses for computers.

- * Saves time in processing student data. Teacher utilities can store and manipulate test scores, generate tests from a test database, and even score exams.
- * Concepts can be taught via CAI software to students in the courses. This may free the faculty to do other important tasks.
- * Facilitates research work by using word processing programs, databases, and statistical packages.
- * Enables faculty to produce basic instructional media. For example, McPaint and MousePaint are excellent to make transparency masters for the thermal process.

In summary, the micro can be used by faculty to perform many useful tasks. It can be a tool, a teacher or tutor, a research assistant, and a programming challenge for some adventurous faculty. In addition, new and exciting software is currently being developed to greatly expand the scope of activities found in the faculty area. The growth in this particular field has been phenomenal. For example, the Center for Software Selection and Evaluation at East Texas State University had received in one week four new grading program to review.

FIVE-STAGE MODEL

The Orientation stage represents the first contact with micros. This exciting initiation usually occurs during a faculty workshop conducted by computer science specialists from a local university. "One-shots" rarely precipitate lasting, positive outcomes. These bit-byte, ROM-RAM sessions emphasize the complexity of the computer system including a liberal amount of programming gems. In addition, no support staff are selected to assist semi-literate computer users in applying the newly acquired skills to help students with computer utilization tasks. Sometimes a school has one, or even a few, micro entrepreneurs experimenting with the hardware in an educational setting. These pioneers can be a important catalyst to micro utilization by other faculty. They tend to be zealots forever promoting the microcomputer cause. Overall, the Orientation stage is usually a dismal failure in recruiting and inspiring faculty to be micro users.

Stage Two is referred to as the period of confusion which is often characterized by the development of computer-related stress. Through self-motivation certain faculty members will seek out useful software programs for course adoption. In this stage, faculty are beginning to use programs in the classroom and for processing course-related data. However, many are experiencing difficulty using basic software. In addition, to numerous faculty the microcomputer is still a mysterious box which causes tension. Limited progress occurs in the second stage.

Stage Three describes a much higher level of microcomputer application to the basic teacher education curriculum. At last support is available to assist faculty in software selection, database-searching, and software utilization. Faculty workshops are organized to promote knowledge and skills in selecting software, developing teaching strategies, planning learning activities, and evaluating computer-based study. The sessions are usually conducted by a well-qualified educational computing specialist. Seldom do faculty request workshops involving programming the micro in BASIC, Pascal, or even logo. Faculty in Schools of Education have busy schedules involving teaching, research, and service which leave professors limited time for programming. With additional support, faculty members are increasing the use of computer-assisted instruction and computer-managed instruction with their courses. Support in the form of computer assistance and software and hardware availability is crucial to any staff development effort in educational computing. With increased use, faculty will request more micros and software. Some professors even will request a micro system for the office. The day will come when micros will be considered just another piece of office equipment. In summary, this stage represents a major breakthrough in faculty utilization. Gone are stressful signs, dust-covered micros, and unopened micro software. On this level, the micro has found a home in academe.

The next stage represents the integration phase. Faculty have ready access to micros and a wide array of CAI/CMI software. Staff development consists of short courses and individual sessions examining software packages and new hardware systems. A wide variety of additional topics can be included depending upon the needs and interests of the faculty. In addition, the education computer specialist should provide orientation sessions for all incoming new professors. By this time, faculty are busy using their office systems to write letters, maintain grades, produce transparency masters, compile a research-related database, and create exams from a test data file. Students enrolled in the classes taught by computer-using faculty are frequently given assignments involving microcomputers. The techniques used by these teachers will be quickly emulated by many future teachers reaching a larger audience during their career.

The last stage in the model is an assessment and evaluation period. It represents a time to stop and check outcomes. Formative techniques can be used to evaluate the current program. In addition, summative strategies involve surveying graduates of staff development and reviewing final evaluations. Confirmative evaluations are simply endorsements maintaining the current program. Formative, summative, and confirmative evaluations represent a global and comprehensive evaluation system.

From initiation to evaluation, represents the normal progression found in some institutions of higher education in the United States. With greater administrative support, more staff could be involved in high-tech seminars involving microcomputer applications.

STAFF DEVELOPMENT GUIDELINES

To assist faculty in planning staff development programs, the following guidelines will be beneficial:

* Use a local "expert" to plan and coordinate the program. A professor from within the university would be more accepted than an outside specialist.

* Plan to incorporate a humanistic design in the planning model for staff development. Because of phobias, faculty need extra help to become computer literate. Use partners, media, frequent breaks, and simple micro packages to get professors started.

* Provide hands-on activities. Skip programming, and emphasize the use of programs.

* Encourage faculty to experiment with the system. The machines are quite hardy and can take some abuse.

* Use a faculty committee to plan the staff development program with some representation from the administration.

In conclusion, the model described in this paper can be used to define the current status of micro use in a school of education. If these schools desire to have computer-using graduates, they need to have more computer-using faculty. A computer-using faculty can influence students for many years. In this high-tech environment, it is paramount that future teachers be exposed to computer-related modeling.

REFERENCES

1. U.S. Department of Education, OERI Bulletin (Washington, DC,1986).
2. S.A. Cory, A Four Stage Model of Development for Full Implementation of Computers in a School System, Computer Teacher (1982) p11.
3. R.A.Gray and Martin, W., Starting a Microcomputer Staff Development Program , School Resources Journal (1984) p8.

WORKING WITH TEACHER SPECIFICATION GROUPS TO DEVELOP EDUCATIONAL SOFTWARE

Graham Turnbull*

ABSTRACT

This is a general outline of the illustrated description that will be delivered at the conference and which details the process of working with specification groups in the development of software. The formation and co-ordination of groups, curricular validation, evaluation, collaboration between teachers and programmers and the development cycle are described by drawing upon a record of development for a recent Scottish package.

AT THE MOVIES

When I was in my first flush of youth, we attended the movies quite a lot. Here, there were a variety of approaches: those who were primarily interested in the techniques *they* could employ given the cinema's environment of darkness and proximity, those who merely used the movie as a precursor to further anticipated approaches after the movie and a few idiots like Douglas and me who actually watched the movies. Douglas enjoyed the films and defended even the least worthy while I constantly criticised and questioned what the films intended.

Douglas is a film critic on a local paper while I once taught English and now help teachers design educational software. There must be a moral somewhere.

MOVIES & SOFTWARE

A fairly loose comparison can be drawn with the way we tend to look at educational software. There are the great many who appreciate the special environment and the opportunities that software can provide, there is a lesser amount who tend to look at software on a "gee-whizz" level and some who want to know the reasons for its structure and argue the whys and wherefors. Incidentally, don't try to map my analogy too closely or this will become "adult entertainment".

There are dangers in all these approaches if we adopt them to the exclusion of others. The environmental strand can sometimes conceal the fact that the teacher may have actually created the environment and the software is simply an adjunct. The adulatory approach omits to examine learning and teaching possibilities and finally the dissector often cuts his/her own throat by leaving nothing that is functional in his/her mind at the end.

All of this serves to introduce the idea that good educational software design involves the fusion of a number of skills and concerns and should aim to provide a variety of outcomes for both the learner and the teacher which dovetail with the curriculum.

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THE SCOTTISH WAY

In Scotland, through the Scottish Council for Educational Technology, we have attempted to provide a structure for this fusion to occur which will lead to the development of public domain educational software packages. The word 'package' has been used advisedly. The aim has been to produce material which offers curricular 'fit'. This covers both articulation with existing courses for those who wish to develop link materials and the possibility of using the package as it stands without extra materials. This implies a package which has software as a component but which also contains other support material.

The 'Apprentice' package, which is my exemplar, contains three booklets, a role play board game, the software and lists of sources for additional resources much of which is free. This is on release just now. The package will only be complete when the Video showing good practice in its use and the Case Study of Development are released in the Summer of this year.

DOING IT THE SCOTTISH WAY

Just how do we get this process to work and how do we ensure that we address the correct constituencies? Like any movie production, there has to be the concept and we are lucky that we have evolved a national machinery to seek out and validate such concepts. But once our 'producer' has started the ball rolling, he must get his director. In our terms, this is a team comprising two types of people: teachers and advisers and officers from SCET.

The teaching team is usually around 4-8 in number but that does not prevent us calling on the expertise of other national bodies during development. SCET supplies an Educational Validation Officer, A Systems Analyst and a Programmer for the project. This provides a stable group which meets at least once a month throughout the project to co-ordinate development, specify and frequently argue. It is interesting to note that no limits are placed on the input that any individual may make to the group. This allows programmers to make educational comments, very often based on their experience of other educational projects, and for teachers to make comments on code and presentation based on their experience of using software in the classroom. Visitors to SCET often ask how teachers and programmers work together. They work very well as long as one does not isolate one group from the other and the development is seen as modular and iterative. An additional aid is the producer's assistant who co-ordinates the development in educational terms but who also provides a bridge between purely educational and purely technical concerns - in our model, that is the Validation Officer.

There is an element of seeding in the formation of the group. If we start with the concept, we already know the sort of specialists we will require in the group and so we attempt to minimise risk by picking the best 'director'. Obviously, we want someone who was involved in originating the concept or *pre-specification*. In addition, we will add at least one person who has been involved in such a SCET development before to provide a base line of experience. If the project aligns with a national curriculum development, we will include a representative from that group and finally we add people on the recommendation of Local Authority Education Departments and on performance as shown at National In-Service Courses. However,the individuals are chosen, the majority are practising teachers. There is a tradition that curriculum development is rooted in the general teaching force in Scotland. After all, it is they who will have to use the package. Further, this makes good sense in terms of design, trialling and modification.

Such groups must be given time to 'bed down'. Often a large number of initial meetings are spent in floating ideas, discussing these and shooting them down in flames. This is not wasted time because it allows the group to develop, through time, a common starting point and a common pool of references. In a team, it would be impossible to progress sensibly if it were to be discovered that members were pulling in opposite directions half way through the project. One can see this as an initial period of educational negotiation. During this period, the aims and objectives of the package are being finalised. These already exist in outline from the pre-specification but need to be fleshed out.

The next step, as a complete group, is the development of a skeleton specification which describes in educational terms the component parts of the final package. The pre-specification is only a concept and so we must move one stage nearer a formal specification through this skeleton specification. It allows the group to examine on paper each element that has been planned, consider balance and the appropriateness of media and decide on the allocation and sequence of formal specification for each module.

The process of specification and development is like movie production, where the scenes are filmed as discrete packets and often out of sequence. The group will start with one particular module. The decision as to which module will be chosen is necessarily a compromise between educational and technical considerations. The teachers want a module that will allow them to dip an educational toe in the water and the coding team want a module that provides basic functionality.

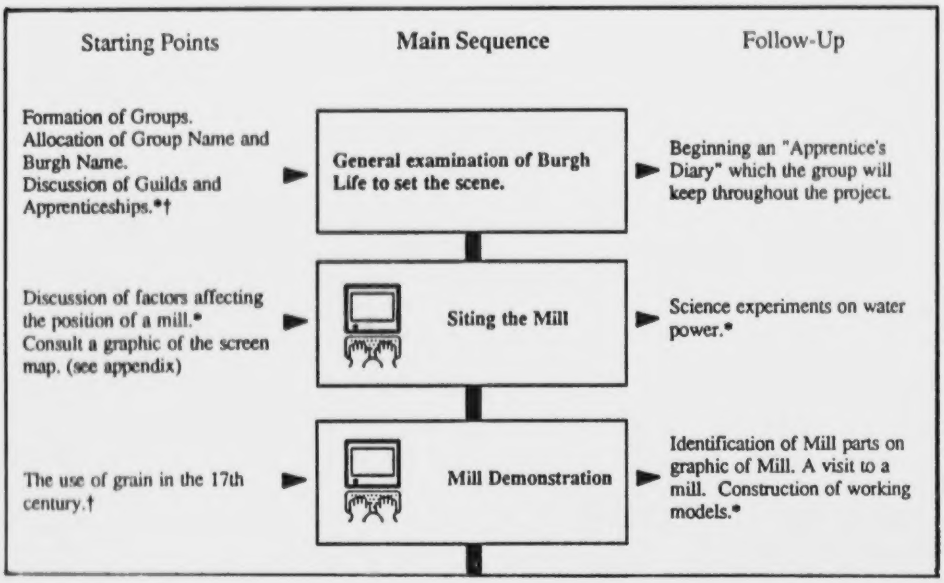
While this first module is being coded groups tend to allocate responsibility for further module specification to individual members or small sub-groups.

At each monthly meeting the group sees the 'rushes' of the module under coding and makes modifications which are then incorporated. Members present their specifications and these are discussed and amended in the light of of the comments of others and also with regard to what we have discovered from previous modules. If a specification is approved, it goes to coding. When the group is happy with a particular coded module, it is evaluated in the teachers' schools and any changes are again incorporated. As the modules build up, we 'edit' them together to give an increasing insight into the final package. This process also applies to documentation and other media .

And so, slowly but surely, we build our package. This allows us a great deal of flexibility. We are not committed immutably to a specific package right from the start. We can examine each section of the package and trial it in the classroom. In this way, we can be intensely critical, discover and design the 'gee-whizz' parts of the package, gauge and subtly affect the environment our package is trying to create, examine the curricular fit that we have achieved and also learn from our trial teachers and pupils about preparatory units that will be required for such a module or what spin-off activities are possible.

Below, you will see an extract from the sort of curriculum web that this type of development created for the package 'Apprentice'. The full web appears in the Teacher's Documentation of the package. This not only allows teachers to map their own approach to the package through starting points and extensions if they are using the whole package but also allows discrete elements to be extracted.

Figure 1 Extract from Suggested Teaching Approach in Apprentice



Starting Points	**Main Sequence**	Follow-Up
Formation of Groups. Allocation of Group Name and Burgh Name. Discussion of Guilds and Apprenticeships.*†	**General examination of Burgh Life to set the scene.**	Beginning an "Apprentice's Diary" which the group will keep throughout the project.
Discussion of factors affecting the position of a mill.* Consult a graphic of the screen map. (see appendix)	**Siting the Mill**	Science experiments on water power.*
The use of grain in the 17th century.†	**Mill Demonstration**	Identification of Mill parts on graphic of Mill. A visit to a mill. Construction of working models.*

Given this modular process of development and review it was discovered that the pupils' role play exercise required a context and so a board game was developed. Among other things, we discovered that individual teachers would require extra support in historical knowledge for the package and so this was prepared.

WHAT THE CRITICS SAY

There has to be independent testing of the package. When the group is satisfied, the complete package is placed in four schools in different parts of Scotland for evaluation. Not only are formal evaluations provided by teachers but also the opinions of pupils are sought. Some of the schools are visited by the Validation Officer for follow-up discussions and inevitably modifications are made to the package.

THE BOOK & THE VIDEO

At this moment two schools are beavering away with Apprentice. One is using it as the focus of the class's integrated day and the other is using it as an additional element in their historical studies. Inevitably, such packages require proper evaluation of use and support over a long term and this is planned. A case study of development and a video of good practice based on the above schools will be published.

Like a good movie, all of this takes time. The basic 'Apprentice' package took eighteen months to develop. Unlike movies, though, time is not only money, time means educational value.

Now, how about some popcorn?

EDUCATING THE MANAGERS OF INFORMATION: WHOSE RESPONSIBILITY?

Guy Garrison*

ABSTRACT

This paper describes the status of education for information management in the U.S.A. in four disciplines that are expanding the scope of their curricula in response to the need for information professionals: library and information science, business administration, computer science, and engineering. Characteristics of the higher education system in the U.S.A. that contribute to this fragmentation are also considered. An alternative solution to the challenge is proposed--the development of full-scale professional schools that take a broad, interdisciplinary view of information and its use, and are able to shape relevant curricula to satisfy the practitioner, leadership, and research needs of a new profession.

INTRODUCTION

As the United States, in common with other industrialized nations, moves ever more deeply into the Information Age, there are expanded career opportunities for the information professionals who produce, acquire, organize, and manage information. A recent article in Business Week, entitled "Management's New Star: Meet the Chief Information Officer," is one indication of the fact that information management, in all its forms, is achieving increased visibility and credibility as a recognizable career [1]. A new field, whose historic roots in librarianship and documentation are easily overlooked in the clamour to fill jobs in the dynamic information industry, is in process of formation.

How well these information managers meet the challenges of the future will depend to a large degree on the competencies they acquire through formal education. However, consensus has not yet emerged on how the people who manage information as a profession are themselves to be educated. It is clear that ever greater numbers of people are handling information on behalf of others; many of these people can rightfully be called information professionals. How were they trained? What changes are likely to occur in the way they are trained in the future? What will be the content of the training? These critical questions need to be asked, and answered, in every country. In my paper I describe some transitions that are now taking place in the training of information professionals in the United States. The situation is dynamic; definitive answers have not emerged; the configuration of future education is still uncertain.

Vast numbers of people rely heavily on information in order to do their jobs. As a result, a growing number of people manage information as their primary work activity. One estimate says that in 1980 nearly one in four jobs in the U.S. was information related, but the author was including everyone from actors to telephone repairmen [2]. A more useful study, published in 1981, estimated that 10,000,000 persons could be classed as information professionals [3]. Using an even more restricted definition, King and Associates identified about 2,000,000 information professionals working in publishing, libraries, information clearinghouses, education, broadcasting, etc., who could realistically be said to be managing information, at a professional level, on behalf of others [4].

The academic establlishment in the U.S. is not, of course, starting from zero in designing programs for the preparation of information professionals. Programs are already in place to meet many of the needs of society for information specialists. As one example, 53 accredited graduate programs in library and information science annually produce nearly 4,500 graduates. These graduates increasingly find careers in non-institutional settings, outside conventional libraries. Computer science and engineering departments continue to produce many graduates who readily find information-related employment in business and industry. Business schools, also, are recognizing the challenge of preparing information managers at a level higher than that represented in the phrase data processing, which is now largely obsolete.

What has yet to occur, however, is the emergence of distinctive full-scale professional schools that take a broad view of information and are able to synthesize the best from existing disciplines, give it a new focus, and produce graduates who will be the leaders of the Information Age. The rapid advances in information technology and the growing importance of information to the conduct of life should inevitably

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lead to the development of such programs. Academic institutions are beginning to recognize this. Change is occurring, but at the present time the direction of change is not clear. The rather timid efforts seen currently to graft information training onto existing professional or discipline-oriented programs will not meet the demand arising from the world of practice. Meanwhile, since the information field has grown so rapidly, it has been necessary to train many information workers outside the university environment. Much information education is now done on the job, in corporate training programs, and in workshops and seminars provided by professional associations and by educational entrepreneurs.

As background for a description of the academic changes that are taking place in the United States, it is useful to point out some of the characteristics of American higher education that affect the way academic institutions respond to changes in the job market of the kind we see today in the information field. First of all, it is important to recognize that there is no tradition in the U.S. of central planning for manpower production. There is no bureau monitoring manpower needs and telling universities what fields to increase or to decrease. The system of higher education is highly decentralized. In general, universities are free to develop programs in any fields that they think are congruent with their missions, or are marketable. The professional schools are integrated into the universities and do not stand alone. The federal government, except through limited incentive funding, is not involved in determining the structure or content of higher education. Even at the state level, from which most funding comes for the public universities, there is little effort to tell the universities what programs are to be encouraged or discouraged.

Another major factor that shapes professional education is that the professional societies, not the government, control accreditation of programs. Acting in the public interest, and through voluntary efforts, many professional societies have established standards that influence the content of curricula. Thus, the development of educational programs in an emerging field of interest (e.g., the information field) is heavily influenced by the involvement of relevant professional societies in the accreditation process.

In the U.S. today, several disciplines are responding to the need for more information professionals. Each takes, in general, a conservative approach to this task, appearing to see the training of information personnel as an extension of the established discipline, not as something that demands realignment of present educational patterns. There are four disciplines that are especially active in expanding their curricula in response to the need for more information professionals: library and information science, business administration, computer science, and engineering. The rest of this paper describes briefly what is happening in each field.

LIBRARY AND INFORMATION SCIENCE

Schools of library and information science in the U.S. operate at the graduate level. The M.S. or M.L.S. degree is the standard credential for professional standing. Over the past 20 years, the more progressive of the 53 accredited programs have made heroic efforts to enlarge their coverage to embrace documentation, information science, information resource management, and information systems, which they consider to be natural extensions of traditional curricula [5]. About one graduate in three now finds employment, not in a library, but in some aspect of the larger information sector, typically business or government. Formal education for librarianship is a century-old tradition in the U.S., but the field faces difficulties in extending its hegemony into cognate areas [6]. Several leading schools have made bold efforts to do this. Specific examples follow:

University of Pittsburgh: The School of Library and Information Science, through an Interdisciplinary Department of Information Science, offers M.S. and Ph.D. degrees in information science, distinct from the long-established M.L.S. degree. Pittsburgh recently added a Master of Science in Telecommunications program. They also offer a baccalaureate degree (B.S.) in information science.

Syracuse University: The School of Information Studies, while retaining its long-established M.L.S. degree, offers a separate M.S. degree in information resource management and a Ph.D. in information transfer. Syracuse recently added an undergraduate degree program in information studies.

Drexel University: The M.S. program at Drexel meets ALA accreditation standards for librarianship, but is flexible enough to prepare graduates to manage information service activities in all kinds of organizations. In 1984, a new B.S. degree program in information systems was begun. This program covers both the technical and behavioral aspects of information systems design and management. A Ph.D. program has been in place since 1974.

BUSINESS ADMINISTRATION

The structure and content of business curricula is strongly influenced by the Assembly of Collegiate Schools of Business. In the past decade there has been a serious effort to make room within schools of business administration for both graduate and undergraduate specializations in information systems. Even though since the post-World War II era American business has been transformed by electronic data processing, information technology, and telecommunications, the educational establishment was slow to respond with appropriate curriculum changes. Programs in general were aimed at producing managers and paid little attention to support functions such as the management of information.

As the move to develop specialties in information systems within business curricula gained strength in the 1970's and 1980's, two important professional associations, the ACM (Association for Computing Machinery) and the DPMA (Data Processing Management Association) developed model curricula which they hope will shape the content of this area of study [7]. The ACM and DPMA model curricula both start from the premise that information systems training should grow out of a business orientation. Some critics feel that this orientation is too narrow to do justice to the complex field of information studies, but the sheer size of the business school establishment gives considerable momentum to the trend of viewing information systems as part of business.

In a manner typical of business school programs, the nomenclature used to describe the field has changed several times in a decade. Management Information Systems is one phrase in common use. The phrase Decision Support Systems is often used to convey essentially the same content. One also sees Information Resource Management used to describe this area of activity although the term has been sullied somewhat by over-identification with government settings. However, at present, Information Systems seems to enjoy favor as a more generic term.

The business schools obviously are interested in keeping their present position with information training and perhaps expanding this position. In general, computer science and engineering disciplines are ready to cede to business schools most of the concern for applications of computer and telecommunications technology. However, the division of the body of knowledge, the areas of research, and the areas of training, is far from fixed. Information systems training at its best requires multi-disciplinary efforts and is unlikely to be totally absored by business schools.

COMPUTER SCIENCE

Can the need for greater numbers of well-trained information professionals be met through established university departments of computer science? Experience to date indicates that this is not likely. To simplify a complex issue, it is safe to state that computer science, as organized today, especially in the better universities, sees itself as an academic discipline and not as an applied, professional field of study. Such a stance makes it difficult to produce practitioners.

Growing essentially out of mathematics and with a strong affinity to the hard sciences, academic computer science is concerned with computer architecture, languages, software development, and large-scale computation. Until recently, computer science showed little interest in the potential of computing for solving the routine problems of daily life, either in the office, the workplace or the home. The departments were little concerned with preparing students to take into account the behavioral aspects of computer utilization.

Although computer science itself, in its origins as a discipline, was multi-disciplinary, it has not, in its maturity, continued to take part in the convergence of interests that is demanded by the information explosion of today. There are some signs that computer science programs (perhaps in response to the demands of the marketplace) are beginning to realize that computer science for computer science's sake is too narrow a position. It is not uncommon to find computer and information science linked in a departmental name. One finds an occasional university where computer science, information science, and information systems are brought together in one large unit. One example, George Mason University (in suburban Washington, D.C.), places in a broadly-based School of Information Technology and Engineering separate departments of Computer and Information Sciences, Electrical and Computer Engineering, and Systems Engineering. If components were added to cover the cognitive aspects of information systems and the management of information resources, one might almost see here a model for training the complete information professional.

ENGINEERING

The uncertainty in U.S. universities about where to place expanded programs to train information professionals is not unlike the related uncertainly of two decades ago on where to allow computer science to develop--as part of applied mathematics or part of engineering? In recent years, the specialty of information science has attached itself to a variety of host disciplines, including engineering.

In some universities where computer science is closely associated with engineering, there is a fair amount of attention to the design and use of information systems. Thus, as the need for trained information personnel accelerates, it is not surprising that these engineering schools have become more involved with applications. Areas currently of great interest to information systems and at the same time to engineering include artificial intelligence, expert systems, software engineering, and human factors engineering.

In positioning themselves to train more information practitioners, engineering schools are impacted by two forces. The push for technical innovation in the devices used to store, manipulate and transmit data is accompanied by an equally insistent push for better ways to allow people to use the data. The impact of information technology on our lives is pervasive; engineers cannot ignore the human aspects of information transfer. Do engineering schools have the will to modify their curricula to include more emphasis on the human factors aspects of information processing and use? If not, can they become the appropriate vehicle for training information professionals? Can they move beyond a concern with information representation to include also a concern for its organization, management and use? If an information system is to be used, it must be well-matched to the capabilities and limitations of its users.

Again, one comes back to the position that what is required today is a new kind of academic unit, one that assembles its faculty from a variety of disciplines, provides a series of carefully articulated baccalaureate and graduate programs, promotes inter-disciplinary research, and focusses its efforts on the interaction between users and information systems. Such an academic unit would not be limited in scope to business, to libraries, to one discipline, or to one technology. Its mission would be to facilitate the application of information to human needs in the broadest possible sense. The very structure of society is changing as we become increasingly dependent on information; it is clear that academia must realign its resources to cope with this challenge.

REFERENCES

1. "Management's New Star: Meet the Chief Information Officer," Business Week, October 13, 1986, pp. 160-72.

2. Michael Rubin, Information Economics in the United States. Littleton, Colorado: Libraries Unlimited, 1983.

3. Anthony Debons, et al., The Information Professional: Survey of an Emerging Field. New York: Marcel Dekker, 1981.

4. King Research, Inc. Library Human Resources: A Study in Supply and Demand. Chicago: American Library Association, 1983.

5. Since 1926, the American Library Association has controlled accreditation in the field of librarianship. Since no other professional society has opted to take control of information science accreditation, ALA also assumes this role. Recently, ALA has been promoting the development of an Inter-Association Committee on Accreditation.

6. Koenig, Michael E.D. "Education for Information Management," Library Trends 34(4),715-728, Spring, 1986.

7. "Information Systems Curriculum Recommendations for the 80's: Undergraduate and Graduate Programs, "Communications of the ACM, 25:781-805, November, 1982. The DPMA Model Curriculum for Undergraduate Computer Information Systems. Park Ridge, IL: Data Processing Management Association, 1985.

THE ICAL CONSORTIUM - A STIMULUS FOR CHANGE

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J L Temple[5] S Doherty[6] R C Coates[7]

ABSTRACT

The history of Computer Assisted Learning is littered with examples of new projects and prestigious developments each with their own individual successes and lessons. This paper outlines the ICAL project and the reasons for it's creation; it analyses some of the problems facing TBT developers, and outlines mechanisms now in place which will help to secure their resolution.

TBT developments have taken place on incompatible systems and withou common authoring standards. The high cost of development has been compounded by the need for staff training to enable practitioners to exploit new media and new materials. In parallel to the shift in emphasis from teaching to learning is the need for a curriculum response which embraces new content contemporaneously with new media for delivery.

The ICAL Consortium is founded upon a collaboration of academic interests and companies in the computer industry. Its aim is to address identified problems in a pragmatic activity based approach. Common hardware supporting UNIX and MS-DOS, a common authoring environment and a shared use of products developed, as well as a forum for exchange of views and information, will act as an important stimulus for change.

PROBLEMS FACING DEVELOPERS : INHIBITORS OF PROGRESS

We live in the Information Age. More precisely, we live in a computerised information age surrounded by technology. Most new technical innovations are to do with how data, in one form or another, is captured, compacted, stored, accessed and, above all, communicated.

With the increasing capabilities of new equipment, a major part of total machine resource is available to improve the Man Machine Interface (MMI). Many techniques came form the 'Apple Mac' environment. Software products such as GEM, MS-WINDOWS and X-WINDOWS are now widely used to improve development productivity whilst giving the user a more standard MMI. Widely used products at a higher level have been harder to come by; authoring languages represent a good example. There has been a plethora of languages, environments and potential target environments. This has been inevitable given the changes in operational contexts that have occurred over time. Nevertheless, a few families of products are now beginning to emerge as 'de facto' standards, albeit with limited scope.

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1. British Olivetti Ltd and Chairman ICAL. 2. Olivetti SpA and Deputy Chairman ICAL 3. DES, Computer Board and Director SWURCC 4. Director Computer Centre The Queens University Belfast 5. Principal Coventry Technical College 6. Manager Educational Software Group The Open University 7. Education Manager Acorn Computers Ltd

In some environments the techniques of Technology Based Training (TBT), including Computer Assisted Learning (CAL), are already in widespread use. They are concerned with the manipulation and communication of information. Good information is a pre-requisite of knowledge acquisition and TBT permits a wider availability of learning material in an environment in which information must be accurately delivered an understood.

At the same time the skills of our 'teachers' have not developed in time with the changes in curriculum delivery nor in tune with technological innovation. The transition from teacher to 'knowledge engineer' is considerable. The change of focus away from teaching and towards learning is even more significant in what it has to say about the operational contexts in which knowledge transfer takes place.

A major inhibitor of progress has been the professional independence of teachers and their historical prejudice not to collaborate with one another or with industry. This situation is now changing but a further emerging problem is the more visible absence of a structure to co-ordinate or manage learning activity. Each course at all levels has been lovingly handcrafted. Where TBT has been used it has been equally individually produced. There are no 'kitemarks'.

Associated problems have been the cost of buying in professionally developed TBT equipment and the software, the absence of a consensus on hardware or software compatibility, and the difficulties, both legal and technical, involved in tailoring material to the specific requirements of the particular course. The latter problem arises in part from the lack of awareness by curriculum developers of the potential of TBT; greater awareness at the formative stage has led to better material than has arisen from the 'computerisation' of existing material but there is still a tremendous dearth of good quality generic courseware.

The problems are thus considerable but we believe that we can no longer delay in identifying, confronting and seeking to overcome them. The remainder of this paper discusses an important initiative which represents our attempt to make a positive contribution to their resolution.

THE ICAL CONSORTIUM

The Consortium currently numbers 15 organisations who are based either in industry or in the academic world. They have all recognised the problems that exist, collectively decided to take action, and are now collaborating to address these problems. It is inevitable that, when the talking stops and close collaborative action starts, any group must be able to agree on common standards. These are ours in this joint project:

The Common TBT Environment

Hardware:	UNIX S V Mini (3B2 or LSX) and/or PC
Operating systems:	UNIX System V, MS-DOS (MS OS/2)
Graphic standards:	EGC & EGA, X-WINDOWS & WINDOWS 2
Authoring environment:	ACCORD (UNIX S V, UNIX 386 or MS-DOS)

Accord derived from the PLATO environment originally developed at the University of Illinois; it involves a comprehensive implementation of the TUTOR language. It has many interactive tools to assist the author in writing courseware and, through a UNIX network, it is particularly strong on managing the delivery, assessment and control of courseware.

Olivetti have provided the minimum basis for the authoring environment under a subscription agreement with the consortium members and will provide developers with ongoing support. A number of task-orientated working parties are to be established; they will focus on specific aspects of training technology. The general direction of the Consortium in this, its formative period, is in the hands of the Steering Committee, the members of which have contributed to this paper.

The Consortium will not restrict itself to academic education but will focus equal attention on the educational tools required for employee development, against a broad cross-section of industry types. It will accordingly welcome commissions, expressions of interest or applications for associate membership that are in line with its objectives and supportive of its philosophy.

The main line development of the integrated ICAL environment we are seeking to achieve will require the full exploitation of existing and future hardware technologies. We anticipate that each component sub-project within this initiative will eventually be integrated fully into one comprehensive European ICAL systems environment.

PROGRESS TO DATE

The basis on which the Consortium has been formed is one of collaboration amongst the participating members. In future each of the institutions will be developing material which will not only meet its own needs but which can also be used by other Consortium members in their response to their own requirements.

Collaboration will only be successful if there are pre-defined standards. The ICAL Consortium has addressed this problem by defining common authoring and hardware environments and by specifying UNIX and MS-DOS as the host operating systems. All members have agreed to provide courseware material to those standards.

The time taken to develop good courseware remains one of the major impediments to an increase in the use of TBT material. In joining the Consortium, each member undertakes to share the courseware each develops with the other members. This sharing of the results (and consequently the workload and costs) is one of the major advantages of membership of the Consortium.

The main source of the material which the Consortium distributes will be the institutions which constitute its membership. Too often courseware has been developed in Universities, Polytechnics and Colleges by an individual lecturer to meet his own teaching needs. It is devoid of standards and almost always only local in its applicability. As such, it would be of little use to the Consortium.

Therefore, each institution in the Consortium will have to address this problem by introducing the idea of collaboration and common standards internally.

To individual practitioners, this may appear at first to introduce an unnecessary additional burden when they are only interested in meeting their own (and often immediate) teaching needs. However, the acceptance of standards makes collaboration possible, and by collaboration and the sharing of courseware material, the overall workload can be reduced. It is the overall benefits of the Consortium which will act as the stimulus for change which will be promoted within the constituent members.

CONCLUSION

In short the ICAL Consortium is about putting CAL technology's power into the hands of educationalists and/or subject experts through the development of effective, easy-to-use tools which facilitate the delivery of courseware by computer in a multi-media learning environment.

The ICAL Consortium is also about the more effective use of scarce and valuable resources through sharing expertise, development costs and products. It is also about the acceptance of agreed and sensible standards.

"Putting Learner at the Center" was a powerful stimulus in the development of Open Learning. The ICAL Consortium is working to ensure that the individual learner has readily available the knowledge he or she needs in its most accessible form - now made possible through the collaborative development of the products of technological innovation

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COMPUTER EDUCATION IN DEVELOPING COUNTRIES: FACING HARD CHOICES

Joao Batista Araujo e Oliveira*

ABSTRACT

The present paper discusses three issues related to the adoption of computers for education in developing countries. First, it must be emphasized that the differences between developed and developing countries create **different contexts for technology adoption**: in developed countries, educational technologies are add-on inputs to the educational process. These countries can afford to experiment, make mistakes, and live with inefficiencies. On the other hand, developing countries live in a context of scarcity, in which allocation of resources for new technologies can only occur at the expense of basic inputs. Thus, educational technologies can only be justified to the extent that they can yield cost effective results; they should be considered for improving teaching quality where quality is very expensive to reproduce, or to substitute for the lack of teachers or of schooling opportunities that cannot be made available with conventional technologies. Second, there are different meanings attached to the concept of **computer literacy**, and they vary according to the level of a country's economic, industrial and educational development. Hence the need for compatible computer education policies. Third, developing countries cannot replicate massive projects of computer education of the developed world. **Effective policies** for developing countries should include criteria of selectivity cum flexibility, appropriate software development strategies, and adequate organizational support, especially teacher involvement.

INTRODUCTION

The challenge for politicians and decisionmakers in developing countries is to reconcile a number of conflicting imperatives-- their own fascination with computers, widespread pressures to respond to changing labor markets, the need to respond to society's aspirations, and the anxieties provoked by automation-- with the provision of effective conditions for the use of computers in schools. If they do not introduce computers in education, developing countries fear falling even further behind the developed ones, but to be effective, decisionmakers must carefully analyse for what, for whom and how computer education should be designed and implemented.

ABUNDANCE VERSUS SCARCITY

Technology adoption has different meanings according to a country's level of development. Rich countries usually adopt technologies as an add-on resource to complement an already acceptable level of educational quality. Computers are seen as yet another input, and resources allocated for these new technologies do not require the sacrifice of other essential ingredients, such as teacher salaries or textbooks. Developed countries can afford expensive, massive policies and incur in the risks associated with innovative research and development efforts and tolerate inefficiencies commonly associated with large projects. Existing research evidence from wealthy countries illustrates that computers can work effectively under certain conditions, but significant cost effective results are achieved only under very special circumstances.

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In contrast, in developing countries, the major challenge consists of extending schooling of acceptable quality to the majority of the population in the face of scarce resources, and of a limited number of adequately trained teachers and school facilities. Any new expenditure will affect teacher salaries, the expansion of educational opportunities, or the provision of other essential educational materials. Given the resource-poor context in which schooling takes place in these countries, the provision of adequate instructional materials can have a much stronger effect than in developed contexts, as has already been demonstrated in research on the effects of improved distribution of textbooks and distance learning. Technologies can thus only be justified to address critical needs in education if they can result in significant savings as compared to traditional methods. Computers have a great promise in the 3rd World not only for teaching computer related skills but also as a learning tool to teach conventional subjects in which there is shortage of qualified teachers. To suceed, however, policies must be very selective, and take as a point of departure the needs to which the technology will respond.

DIFFERENT MEANINGS OF COMPUTER LITERACY

In the developed world, computer literacy has taken on a number of different meanings. In the United States and Japan it is generally associated with labor markets, while in Europe it is commonly defined in a broader context that takes into account social and political variables. Comprehensive computer education policies have been implemented in countries such as England, France, Spain and the United States, and, more selectively, in Japan. The results of such programs are difficult to evaluate, given the broad scope of the projects and the limited funds available. Market needs have been generally overestimated, despite localized shortages of skilled personnel. Less than six percent of new jobs directly involve high-level computer skills, and the introduction of computers may also abolish or downgrade the complexity of other jobs. Learning gains have been modest, and costs, staggering. France alone spent over a US$ 100,000,000 for teacher training alone, but the overall availability of computers in classrooms still lags far behind the ambitious plans of these various countries. Many developing countries try to mimick such massive efforts, without duly considering that computer literacy takes on different meanings according to the local level of economic and industrial development. Hasty attempts to introduce massive computer education programs will likely be ineffective because they will be unable to focus on specific problems, and inneficient, because they will drain resources from other scarce inputs without corresponding benefits. They also threaten to create additional inequities within developing countries since it is very likely that they will be implemented only in a few, priviledged schools. Countries like Brazil, China or Korea, for example, might need personnel at all levels of the spectrum, ranging from computer scientists to systems engineers, software developers to assembly specialists as well as many users specialized in specific applications. Others, such as Singapore and Hong Kong, may need fewer computer scientists, but might require its entire population to be familiar with the various aspects of computer utilization, given the high level of factory automation and the pervasive use of computers in those societies. Most developing countries will remain, however, users rather than producers of technologies, and the impact of information technology on them will likely be limited. Thus, the definition of computer literacy and the level of computer education and awareness vary with the nature, intensity and characteristics of the utilization of technology in each country.

THE HARD CHOICES: LESSONS AND IMPLEMENTATION CONSIDERATIONS

Whether or not to adopt computers in education, and who should use them in schools is secondary to answering the basic question: computers for what? Once that is determined, three priorities should help guide policy design and implementation.

Selectivity cum flexibility. The absence of unlimited resources suggests the need to design selective policies to introduce computer education in developing countries. Priorities should follow from the analysis of the economic and industrial environment, as well as from the characteristics of local educational systems. Computers, like other technologies, may be more effective when their use is targeted at pressing problems and designed to deal with major deficiencies of educational systems or individual learners. The level of utilization and the disciplines will necessarily vary from country to country. Careful cost analysis must be undertaken, and in some cases, this might reveal that other proven technologies, such as textbooks, peer tutoring, interactive radio, or distance learning are still not in place, and would be more appropriate for the specific need under consideration. Using computers to improve verbal, analytic and communication skills, mathematics and science education deserves serious consideration, not only because teaching of these subjects is more deficient in developing countries, but also because they provide students with important skills applicable to computer related tasks. The use of computer software to replace expensive equipment in vocational/technical schools has also been demonstrated to be a cost effective application. Policy flexibility is necessary to allow schools and teachers room for experimentation and innovation. For training in specific skills, private and non-formal arrangements have been successfully attempted in countries such as the Phillipines, Korea and Brazil. Learning about the use computers takes time and can only be achieved if projects are carefully monitored through adequate evaluation and research.

Appropriate software. Software can be bought, adapted or developed. General purpose software such as word processors, calculators, data bases and spreadsheets can be easily adapted and be of great use in a number of applications. Software must be appropriate to its context; not only must it be relevant to local educational problems, but it must also fit into existing curricula. Otherwise computers will not be effectively utilized in schools.

Institutional support. Computers can be introduced either to improve existing educational practices or to provoke major changes in the educational process. The former is usually the case, and the second, to suceed, requires major organizational and structural changes in schools and incentive systems for teachers. In all cases, adequate training and the involvement of teachers is a pre-requisite for the success and the long term sustainability of educational innovations.

CONCLUSION

Policies are not conceived in a vacuum. Existing policies concerning computers in education were either explicitly formulated by industrial ministries, came about in response to pressure from the computer industry, or resulted from the need to produce graduates for the labor market. They may also result from the availability of donated equipment, the existence of trained experts or the fear of lagging behind. Developing countries are unlikely to be more efficient than rich ones at implementing broad computer education strategies. They can be more effective, however, to the extent that they can establish clear priorities, focus on targeted problems and develop creative strategies. Besides preparing specialists for specific computer related tasks, they can use these new technologies to improve the quality of their educational systems, particularly in critical areas such as analytical and communication skills, mathematics and sciences. If accompanied by careful evaluation and research, these focused attempts can help these countries to develop competence with the use of computers and establish self-sustaining conditions before embarking on more comprehensive and costlier projects. Any policy, broad or limited, will need continuity, adequate funding and sustainability in the long run. Otherwise, computers will vanish as quickly as other educational fashions, leaving behind huge bills to be paid.

INNOVATION SUPPORT BY NETWORKING COMPUTERS AND MERGING DATABASES

Peter McKenna*.

ABSTRACT

Innovation support by Networking computers and merging databases was a long term objective of the Docdel Invisible College project supported by the European Community. A number of lessons were learned from the projects. They are incorporated in the design of support for innovation by the National Information Technology in Education Centre (NITEC).

INTRODUCTION

Innovation support is taken to mean the making available information about new processes or strategies or people involved in them so as to enable interested parties to take advantage of others experience, expertise or development work.

DOCDEL INVISIBLE COLLEGE PROJECT

During a two year project supported by DG X111 of the Commission of the European Community ten higher education institutions in France, Ireland and the UK carried out an experiment which involved setting up 3 linked computer networks, each of which had its own database and all of which contributed to a parent host database. The purpose of the linked computer network and databases was to provide support for innovation in the participating institutions in the areas of resource management, faculty & staff development and information technology.

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DOCDEL AND INNOVATION SUPPORT

The success of the project in supporting innovation was studied from a user perspective. Users' views of the system were recorded by questionnaires issued before and after the experiment. Interviews were held with system managers at the different sites and also with a representative sample of users. Audit software was also used. The major benefits identified by users were :

Increased awareness of the work of colleagues.

Interaction and joint authorship with people in other institutions.

An important teaching tool to demonstrate a complete but usable system.

It is not surprising that 87.5% of users indicated that the destination of information was outside their own institutions.

A disappointing finding was although 53% of users hoped to collaborate with others, only 25% actually did so. This difference between Expected and Actual Collaboration reflects the organisation and technical difficulties asociated with networks and databases. Organizational difficulties arise because of previous investment in incompatable systems or organisations inability to make available terminals, ports or modems to potential users. Technical difficulties arose from slow response times and difficulty of system use, leading to a high level of default logouts.

The single most persistent message which came from the users and managers of the system was the need for simplicity. This was best expressed by one user in the following way:

" The key to such systems is Ease of Access."

NITEC AND INNOVATION SUPPORT

In the light of this experience it has been decided to refine the system developed during the Docdel Incoll project to support the introduction of new information technologies into the school system in Ireland.

It was decided to call the new system the NITEC NETWORK.The key characteristic of the sytem was to be its simplicity. The major steps taken to ensure this were as follows:

An intelligent modem eliminating dialing/logon procedures.

Direct access by all users to a natural language type of search facility.

Single keystroke access to a bulletin board, user profiles and electronic mail.

Transparent access to computers with a communications facility giving simple functionalities.

A dedicated computer to provide immediate response to multiple users.

Logon access to a mail facility.

These developments enable schools which have a computer with an RS232 communications facility to seek, obtain or provide information to the NITEC computer via the Irish Public Packet Switched Network. The NITEC computer can be accessed by anyone who has the correct address for the NITEC computer, which can be stored and dialled automatically by an intelligent modem.

The information on the database will be stored under the following headings:

* Administrative Software

* Curriculum Software

* Guidance Information

* Teacher Development

* EEC Intiatives

* Information Technology Prospects

The software sections will contain descriptions and evaluations of software developed under the auspices of the Department of Education (Ireland) or made available via projects sponsored by the Commission of the European Communities.

The Teacher Development Information will detail any self-learning packages or other types of courses which assist teachers improve their knowledge, understanding or professional expertise in the new information technologies.

The Information on Commission of the European Communities' intiatives will contain information about EEC sponsored activities as well as details about new initiatives relating to the new information technologies in schools in the member states of the European Community.

The Information Technology Prospects will contain information of interest to pupils who might wish to know what kinds of job prospects there are likely to be in the field of Information Technology Applications in the coming decade.

Of central importance to the support of innovations such as will be described in the NITEC databases will be a list of User Profiles accessible to all users. This will list users, their interests, experience and expertise. Many of the developments referred to in the databases will have been the work of those listed in the user profiles. Users who download programmes because they find them interesting but who wish to be advised about the optimum implementation of the software, given their own particular circumstances, can contact the authors via electronic mail. Advice can also be sought from other users who have experience in the same or related subject areas. This kind of support and the flexibility it provides in the implementation of innovations should be one of the major features of the NITEC NETWORK.

A six month pilot implementation phase which begins in January, 1988, should help to refine the network and databases into a simple but powerful tool for innovation support.

THE INFLUENCE OF TELEVISION ON ENGINEERING EDUCATION IN THE UNITED STATES

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ABSTRACT

Trends in the use of Instructional Television to deliver engineering education within the United States are reviewed.

INTRODUCTION

Live instructional television (ITV), in support of engineering education was developed in the 1960s. The Genisis System was developed by the University of Florida and served the northern region of that state. The Tager System was built by a group of high tech companies in the Dallas-Fort Worth (DFW) metroplex to bring to their employees graduate engineering courses offered by several area universities. Recently, industries, particularly Texas Instruments, have begun offering courses in specialized topics. Stanford introduced a system that serves the San Francisco bay area. These ITV systems have proven the educational and economic feasibility of electronically extending the engineering classroom walls wherever a critical number of students are concentrated in a relatively few industrial locations.

In the beginning ITV systems consisted of live one-way video carried by either a closed circuit microwave link or Instructional Television Fixed Service and talk-back either as a part of the microwave system or using quick dial telephone. These systems have matured to the point where both faculty and students believe that courses received via ITV are essentially equivalent to courses taken conventionally on campus. Both Stanford and the universities participating in the Tager system have collected data that establish the validity of these conclusions.

Now that the validity of such delivery methods are accepted, it will be beneficial to persons responsible for engineering education to review current trends in extending the ITV concept and to predict future trends. This paper will do so from the point of view of the College of Engineering of The University of Texas at Arlington (UTA).

UTA's considerable ITV experience began with participation in the Tager delivery system from the early 1970's and has grown to the point where we presently offer nearly 40% of all courses offered on the system. Currently we operate two studios from 8AM to 10PM five days per week. Fall enrollment was 472.

Our interest in delivering this paper, however, stems from our commitment to greatly expand our ITV capabilities to better address industrial needs thereby contributing to regional economic development. Under the leadership of our new Dean of Engineering, John McElroy, UTA is increasing the number of ITV studios from two to five. Additionally, UTA's newly created Automation & Robotics Research Institute (ARRI), a 48,000 sq. ft. facility sited in an industrial park seven miles

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from the main campus with a technology transfer and applied research mission, will be integrated into the TAGER network during 1988. Beginning with one studio, ARRI will expand to four studios with demand. Planned curricula center on both credit and non-credit instruction related to manufacturing, automation and robotics to complement engineering curricula from UTA and other universities on the network. Mixing classroom lecture and discussion with videotaped and live laboratory demonstrations will be the style of operation.

Dean McElroy, as former Vice President of Hughes Telecommunications, knows the value of ITV delivery systems from the industry perspective. Because of his technical expertise in telecommunications and his concept of the role that UTA must play in meeting the educational needs of the high technology industries in the DFW metroplex, he committed significant resources to this expanded delivery capability. In a large part, this paper sets down the planning for UTA's ITV expansion. We believe that the problems and opportunities facing this university are sufficiently similar to those of other engineering institutions that the conclusions drawn should be generally applicable.

WEAKNESSES OF EARLY ITV SYSTEMS

The greatest shortcoming of the early ITV systems was the excessive costs of the delivery system when the viewing locations were more than about 50 miles from origination or where the total number of students being served was small. From industry's point of view, a second disadvantage of live ITV was the rigidity of fixed university class schedules that did not allow for unpredictable work schedules of full time industry employees.

TUTORED VIDEO TAPE

To meet these serious limitations, Stanford University began in 1973 to deliver outside the 50 mile broadcast radius using a process they called Tutored Videotape Instruction (TVI). The rest of the information in this section is paraphrased from a report presented by the Stanford Engineering Dean James F. Gibbons to the Association for Higher Education (AHE) in Dallas, Texas on November 13, 1987.

> The first application of this method was made at the Hewlett-Packard plant in Santa Rosa, 100 miles north of the Stanford campus. The use of video tape to replace live broadcast was already established. What was added to the process was the idea that a small group of students taking the course at the remote site should watch the tape together in the presence of a tutor chosen and trained by Stanford from the company's engineering staff. This tutor became the surrogate for the faculty member. The tutor's role was to stop the tape any time a student had a question and to be sure that the question was answered before the tape playing resumed. In the event that no one in the class, including the tutor, could answer the question, the tutor contacted the faculty member teaching the course for the answer on behalf of his class. Students studying by TVI consistently outperform on-campus counterparts by nearly two-tenths of a grade point; and they outperform even more those who study by live TV. This is despite the fact that the academic qualifications of the ITV students are, on average, poorer than those of the on-campus students if examinations are used as the criterion for measurement.

> In hindsight, of course, the educational result that Stanford obtained is not surprising, since the TVI students can ask as many questions as they wish during the lecture and they profit from very thorough group discussions arising in the development of answers to their questions. Neither of these features is available to in-class students or those studying by closed circuit TV.

EXTERNAL DEGREE PROGRAMS-NATIONAL TECHNOLOGICAL UNIVERSITY

Several external degree programs have been established to meet the needs of highly mobile engineers. Such external institutions do not offer courses, but will accept transfer credits from other accredited programs. Other than not offering courses, external degree granting institutions generally have organizational structures similar to degree granting universities, e.g. faculty that develop degree requirements, a registrar that accepts and receives transcripts, and counselors that help students plan programs of academic study. The most noteworthy external program employing ITV is the National Technological University (NTU). NTU offers only graduate degrees and has concentrated its degree offerings in engineering and computer science.

The two most significant contributions made by NTU to the delivery of engineering education are (1) the organization of a consortium of over 20 well established US engineering universities to insure the supply of adequate courseware for its students, and (2) the use of satellite to assure that all students working for participating companies have access to a meaningful curriculum. The financial support for NTU comes primarily from government grants and from fees charged to the participating companies.

In terms of the ideal of making quality engineering education readily available to those that need or want it, the NTU concept has two significant disadvantages. The cost per student enrollment is high and enrollment is limited to employees of participating companies. Since the company's decision to participate in the NTU program depends largely on the cost, and since satellite transponder rental is a significant part of the cost, hopefully, as technology continues to develop the cost of programs using satellites delivery may someday decrease to the point where enrollment costs will be comparable to those for TVI.

INTER-UNIVERSITY PROGRAMS

The increasing costs of developing and maintaining exceptionally qualified faculty has caused engineering colleges to select "pinnacles of excellence" to better concentrate their efforts and more effectively use their limited resources. An unexpected side benefit of the emerging ITV programs is the gradual realization that these delivery systems can not only place quality engineering courses in industry locations but could also be used to share courses among universities. This concept will allow increases in faculty productivity and increase cost-effectiveness of engineering education by expanding the availability of exceptional quality courses at each campus without the corresponding expenditure of additional resources.

Again quoting from Dean Gibbons' report to the AHE, a specific example of a successful inter-university program is summarized.

> "The first application I would like to mention speaks directly to the use of TVI for inter-campus faculty productivity. This experiment was carried out as a collaboration between between Prof. Douglas Hamilton of the University of Arizona and Prof. Fred Lindholm of the University of Florida. Lindholm's research and graduate teaching are concerned with fundamental physical electronics of semiconductor devices, whereas Hamilton's work is focused mainly on the design of analog integrated systems.
>
> "Lindholm and Hamilton have cooperated ... frequently in the past, and both were convinced that the quality of their programs could be enhanced if their students had access to courses taught by the other. To secure this access, they exchanged video recordings of their classes, an idea reviewed and approved by the graduate faculties of their respective departments. ...
>
> "The course was an outstanding success. The performance of the students in the TVI classes in Florida compared very favorably with those of Prof. Hamilton's live class at Arizona. Students like the experience and they have petitioned for more courses taught in this way.
>
> "...(the instructor) pointed out that his workload for this course was significantly less that required for a normal graduate class. However, he had more time available to help students ...(individually) than he would have had ...(normally). ...it is clear that the influence and productivity of Hamilton's lectures have been enhanced considerably by their use at another university, saving unnecessary duplication in the preparation and delivery of lectures."

Other examples of the emergence of inter-university programs using tutored video tapes or live ITV already exist or are in the planning stages in the United States. Stanford and Purdue currently operate a graduate program in manufacturing technology where Stanford has created video tapes and Purdue offers and grades the homework and examinations, and assigns the course grade. The States of Massachusetts and Indiana are originating TVI programming; Virginia offers live satellite delivery. Texas has a statewide delivery network in the planning stages.

CONCLUSION

The ITV concept has matured to the point where quality and economic feasibility are not an issue. Many states and regions are developing delivery networks. Examples of inter-campus cooperation made possible by electronic course delivery technologies continue to increase and more universities are getting involved. UTA, for example, is expanding from two to six (later nine) studios believing that in the future, 40% to 60% of an engineering college's teaching will be directed to continuing education.

The quality of U.S. engineering education will increase because of the wider availability of superior courseware. Faculty will be "smarter" and more productive than ever. Industry will benefit by having a broader and deeper selection of courses, both credit and non-credit. Additionally, all will benefit from the ability to deliver industrially originated instruction.

DIGITAL VIDEO INTERACTIVE - ONE MEDIUM, MANY METHODS

Sandra Morris[*]

ABSTRACT

General Electric announced a new interactive video/computer graphic technology on March 4, 1987 at Microsoft's CD-ROM conference in Seattle, Washington. This new technology, Digital Video Interactive (DVI), provides full-motion, full-screen video, three-dimensional motion graphics and high-quality audio capabilities from a single compact disk, as well as from other high-speed digital media. This is acheived through two custom chips designed at the David Sarnoff Research Center in Princeton, New Jersey. These chips, placed on a custom video board built at the same facility, along with a custom audio board, an IBM PC AT or compatible computer, color monitor, and CD-ROM player bring together the technologies of computer and television. DVI provides one hour of full-frame, full-motion video to be played from the compact disk. In conjunction with the research that has yielded the custom chips, research has also been conducted surrounding the development of specific applications of DVI, as well as general application issues and techniques. This paper provides an overview of DVI technology and its applications in education.

INTRODUCTION

Digital Video Interactive is an integrated video, audio and graphics technology that allows software programs, text, graphics, sound, and full-motion video to be played from a single digital source. For developers, this means that much of the production and development of interactive video programs can be done on a single digital system instead of an analog source for video and digital sources for graphics and program data. For end users, this means that the system that they use will be more compact. For both, it means that they will be able to store more information (up to 72 minutes of full-motion video on a single compact disc), and that they will have increased flexibility in the development and use of applications.

DVI Technology consists of three distinct parts: proprietary video compression algorithms that allow motion video to be stored and played from a variety of media, including CD-ROM; DVI video and audio boards that decompress video and audio and display the video; and the DVI system architecture that integrates the audio, video, graphics and text via the personal computer. Prototype video and audio boards, running on a standard IBM PC AT or compatible, were developed at the David Sarnoff Research Center in Princeton, New Jersey, and were unveiled at Microsoft's Second Annual CD-ROM Conference on March 3 and 4, 1987.

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INTERESTING FEATURES OF DVI

The response to Digital Video Interactive since General Electric's announcement of the technology last this year has been very positive. The educational community, the personal computer industry, the computer graphics industry, the corporate and industrial training community, the retailing industry, and government and military trainers have all expressed interest in DVI as a technology that speaks to a particular need they have identified. The appeal of DVI to such a broad range of industries and services is very exciting and has been influential as business plans move ahead in launching DVI products. However, even the most optimistic technophile needs to step back from this acclaim and examine the positive reponse in light of the simple question, "Why?" What is the appeal?

There is some evidence collected both from questionnaires and contacts with companies interested in developing applications using DVI that many of these industries have been waiting for the capabilities of DVI for some time. Many of our contacts feel that the most important feature of DVI is the increased flexibility available to developers when motion video, stills, audio, and graphics can all be worked with in a digital domain, rather than mixing digital data and an analog video signal. The single source medium, whether it is CD-ROM, hard disk or another magnetic medium, is another frequently cited advantage to DVI over other video delivery systems. Increased storage (the CD-ROM can hold up to one hour of full-frame, full-motion video) has been a consideration for some of the interested developers. Others are most interested in the high speed graphics that are available using the two custom chips, VDP1 and VDP2, as graphics processors.

THE DVI CHIP SET

This chip set is really the heart of the DVI system, and all of the features of DVI are available because of the chip design and capabilities. The set consists of two very large-scale integration chips (VLSI). Video Display Processor (VDP) 1 is the Pixel Processor that runs the real-time motion video decompression algorithm. VDP1 allows the combination of text, graphics, and video overlays and contains the Warp algorithm that allows video textures to be mapped onto 3D computer models quickly. VDP1 is a general purpose microprogrammable engine. It can be used in a variety of computer architectures.

The second chip, VDP2, is the Output Display Processor and maps the image to the display device. Horizontal resolutions from 256 to 1024 can be supported by VDP2. Pixel formats of 8, 16 and 24 bits per pixel are available and over 16 million colors can be displayed. Display modes are both NTSC and PAL compatible.

VIDEO AND AUDIO BOARDS

These chips, housed on the proprietary video board, allow the type of flexibility and speed that many innovative developers with experience working in both interactive video and in personal computer applications have been looking for in a technology. For example, multiple display resolutions allow developers to mix and match stills with the highest display resolution, 1024 X 512, with motion video at 256 X 240. Quarter-screen video takes only one quarter of the data space when stored using DVI's compression and display techniques. Information that is best shown in small areas of the screen frees up storage space that becomes available for other data. Frame rates can also be considered as a variable that can be changed according to need. The highest resolution still can be displayed at about 4 frames per second (fps), while motion can be shown at 30 fps. Other speeds can be programmed as well.

The audio board allows for this same type of flexibility. Audio quality can also be varied, depending on needs of a particular application or even within an application. Up to eight tracks of audio can be dynamically mixed down to two output channels. In addition, up to forty hours of audio can be stored in the compressed form on a

CD-ROM. There is the ability to put audio over a still frame and, of course, to mix audio data, still data, and graphics all on the same CD-ROM. In you need a CD to be one-half audio, or 20 hours, the rest of the CD-ROM could be devoted to still frames, up to 5,000 of them, or to one-half hour of motion video.

APPLICATIONS OF DVI TECHNOLOGY

In conjunction with the research that has yielded the custom chips, boards and system architecture for DVI, research has also been conducted surrounding the development of specific applications, as well as general application issues and techniques. Application pilots have been developed using the unique capabilities of DVI for a variety of target users. These pilots have helped us to fully understand the technical implementation of DVI applications and to identify design issues unique to this new medium.

DESIGN FOR EDUCATION

Increased storage and the single source concept of DVI are both features that have implications for educators. Complex material may require more than the 30 minutes of video on one side of a videodisc . The combination of video, graphics, text, and audio can be simplified by having one source, rather than multiple pieces of hardware. In addition, some other more specific features of DVI can be used for educational purposes.

Split-screen capabilities will allow users to compare images, either still or in-motion, side-by-side. Techniques and procedures for everything from short-order cooking to delicate laboratory procedures can be compared for accuracy and results. High-quality graphics can be combined with video so that the student can examine subjects in ways only possible with realistic synthetic video. Imagine a car repair training application where one-quarter of the screen is taken up by a motion video sequence with audio demonstrating the removal of a fuel pump. The student can stop the video and examine a realistic 3D model of a fuel pump in a second quarter of the screen, rotating it and moving parts in order to understand its shape and function. The student can move to another part of the application to select a catalogue of parts to get text information regarding models or costs of fuel pumps. With DVI, this student can move from interactive motion video, to graphics models, to text and picture catalogue all at one workstation.

As mentioned above, the powerful video capabilities of DVI Technology can be put to work in creating realistic graphics by adding video texture-mapping to computer generated imagery. These simulated environments can be used in applications such as flight simulation or driver education, where full, three-dimensional freedom is a requirement, yet capturing real video for all possible combinations is impossible. We have explored the application for this capability through an application pilot that simulates the flight of a WWII Spitfire airplane over a computer generated English countryside. The cockpit of the Spitfire is a real photograph, and the engine noises were recorded from an authentic Spitfire, as well.

Simulation is also useful, of course, in creating environments where it is impossible to film at all. For example, DVI could be used to create an interactive, microscopic world, or in modeling the anatomy of the human body. Expensive or dangerous laboratory techniques can be simulated before they are performed, both for teaching purposes and to help avoid costly or potentially harmful results in an industrial environment.

DVI PRODUCTS

Developers for DVI will be able to purchase hardware products during the second half of 1988. Video boards will include the chip set in a custom configuration with 1M byte of video RAM, expandable to 4M bytes. An optional NTSC digitizer will also be available. The audio board uses a standard TMS 32010 digital signal processor. It is also programmable and available alorithms include real-time ADPCM compression and decompression. An optional stereo digitizer will be available. If developers are interested in applications utilizing CD-ROM, a utility board to interface to a Sony CDU-100 CD-ROM drive is planned. This will also include 128K bytes of additional AT memory and a high-performance joystick interface.

Integrated hardware systems with a host CPU and CD-ROM drive may be available as early as 6 - 12 months after the initial product shipments in 1988. Consumer-priced systems for the mass market could be available in two to three years.

APPLE FOR THE TEACHER

Robert A. Lehman

Introduction

The Lake Washington School district is a medium sized school district with 20,500 students located on the shores of Lake Washington just east of the city of Seattle. Seattle is located in the Puget Sound area in the north western part of the United States in the State of Washington.

The economy of this area is driven by the aircraft industry and those high tech companies which support that effort. In addition to Boeing aircraft such high tech companies as Microsoft, Data IO, Control Data, Rocket Research, and Nintendo are located within the school district. Because the people who work for these type of industries live in our school district they influence a great deal how aggressively technology is approached in teaching their children.

Background/Historical Perspective

Beginning in the fall of 1982, the district began an aggressive approach to respond to the communications needs, wants and desires in the area of technology. At that time, technology was interpreted to be mainly computers and they were seen as having potential for both instruction and administrative uses.

Instructionally, the district developed a five year plan at the beginning of the 1982 school year. By mid'83 the ratio of machines leaped from 200 students :1 computer to 46:1. The goal was to provide "hands-on" experience with computers and were to be seen as tools. It was the intended to use computers in all areas of instruction. Software selection was to be incorporated into the normal cycle for selecting other instructional materials. It was established there should be a central site for cataloging, previewing and evaluating software. An adequate maintenance and repair program was also needed for support. There was to be an awareness of technology at all levels. It was also recognized that staff training, parent training, and community access are essential to the successful use of technology.

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The goals and intentions were admirable. There were many reasons to cheer as the commitment and enthusiasm for micro computers was high. The equipment acquisition was easy, the software structure was established but never really tied to the curriculum. We trained lots of people but few saw the application and became users. A few people were trained many times and they became the "techies."

Administratively we were more successful because the benefits were more obvious and the control over the user was greater. As our enthusiasm waned, the exposure of kids to computers diminished. Our 1982 plan was both ambitious and successful but lacked the momentum to bring about the personal use of technology within our schools.

The Problem

Most agree that technological advances challenge the educational enterprise. As we shape technology to our needs, so does technology change what we do. In education as we increase our resources for learning, the nature of learning will change. Technology advances are influencing all aspects of education--not only the nature of student learning but also the curriculum, teaching, teacher education, the organization of schools, and research on learning and teaching.

We recognized that the effective use of technology and a positive attitude toward change is dependent upon the usefulness of the new technology at a personal level. The technology must be useful to the individual at home or on the job and not be considered an impediment or obstacle to their perception of effective performance. With this premise the first step was to determine how to get a staff buy-in to technology.

The best way to get technology into teachers hands was to design a program which would result in:

- Teachers learning how to use the technology for their own use

- Teachers having instant access to the technology and

- Teachers owning their own machines

Recognizing that teachers would embrace computers if they could only get to know one better, the following proposal was created. Take nine days of training and you can take home your own computer. Over 900 teachers accepted the proposal within the first 48-hour period. As the first class of 450 teachers and administrators started instruction at the onset of summer vacation, the district tied the first knot in the marriage of technology to classroom instruction.

We negotiated an agreement with Apple Computer for 1000 Apple IIGS computers, 1000 copies of Appleworks and help in designing the training. At the same time an agreement was drawn up between the teachers union and the district regarding the exchange of the computers for training time. Nine days of training were exchanged for the computer. An additional two and one-half days were required to earn an Imagewriter II printer.

A training package was designed by using master teachers, "techies" and Apple consultants. Four levels of classes were offered to meet the needs and varying backgrounds of the teaching staff.

The developers of the computer training program combined the need for discovery with the attraction of ownership when they designed the summer course. First step: taking the computer out of the boxes with the owner's name, and setting up the Apple for class use. Once the computer, the monitor, the extended memory card, and two disk drives were in place the empty boxes were stored for later use: taking the computer home.

Computer awareness across the district laid groundwork for creating interest in other forms of technology. The goal of the district is to take the technology that exists now and learn how to apply it in the next five years.

Summary

The success of this approach can be judged on several fronts. First this was a volunteer program and over 98% of the teachers participated. Second, a number of users groups sprung up immediately following the training including three publications. Third, a network of computer coordinators was established in each of the 40 buildings in the district. In addition there have been other efforts such as a huge increase in the use of copier machines (50%), interest in supporting a 15 million dollar levy to support technology in the next five years; over 500 teachers acquiring a copy of a grade book program to assist them in grading students; more requests for copies of software in one week than in the past five years and the major local vendor of software reports a large increase in sales of peripheral equipment and software.

This approach to introducing and training staff on technology has laid the foundation for a district wide technology plan. Within the next five years our ratio of computers to students will drop from 13 to 1 to 4.5 to 1. All students will have access to computer assisted instruction for one hour per week. The enabling technologies of Video cassette recorders and large screen monitors, compact disk-rend only memory, interactive video, video cameras and computer projection equipment will be in every classroom, every teachers will be networked for access to curriculum material and resources, tests and people. A resource center and network are being established to support these efforts.

A REGIONAL PERSPECTIVE

Elizabeth Shephard

Fife is a small Region in the central area of Scotland with easy access to other areas and to the major cities of Inverness, Aberdeen, Dundee, Edinburgh and Glasgow. It has a population of approximately 340,000 with 58,392 pupils in school. Within that number 613 pupils have their needs met in a wide range of specialised provision within the authority. For a number of years the needs of a small number of young people with very severe and complex educational or medical requirements were met outwith the Region. Gradually more facilities were provided within the authority, until to-day, when nearly all pupils have their needs met within Fife. A small number still attend schools outwith the Region, i.e. very specific specialised needs such as the blind.

The philosophy of the Region is based on the needs of the individual, and an effort will be made to meet these needs in the way that is most appropriate and is beneficial to all concerned. The needs will be assessed, then a decision taken about the placement for the pupil taking into account the existing facilities as well as the most appropriate curriculum being offered or which could be provided. This could be in any educational establishment across the Region, either mainstream or specialised provision or both. The important aspect is not where but how it is provided.

In 1981 a decision was made to enter the world of technology, in particular to look at the use of microcomputers. PET computers were bought for each of the schools providing education for pupils with moderate learning difficulties. Very quickly these were changed to BBC computers and, with the help of the Department of Trade and Industry (DTI), Fife was able to put microcomputers into all establishments with special provision. A Working Party was established by the Adviser, Special Educational Needs, to give support to teachers and to co-ordinate and disseminate information across the Region. In early 1983 a Curriculum Development Officer (CDO), Microcomputing, was appointed for Special Education. During this year, the Region drew up a five year plan for the development of microcomputers, which was a clear statement of intent and support to what had already been established.

As part of a National Initiative specifically for Special Education one of our schools became one of three Development Centres in Scotland. This provided us with a focus for in-service training and a testing ground for new pieces of hardware or software. This project was supported by the Department of Trade and Industry (DTI), the Scottish Council for Educational Technology (SCET), the local Education Authority (LEA), and the Committee on Special Educational Needs (COSPEN) - the Special Needs Sub-group of the Consultative Committee on the Curriculum (CCC), main advisory group on the curriculum to the

Fife Regional Council

Scottish Education Department (SED). At this time, COSPEN asked the Region's Working Party to evaluate software and to look at effective ways of using the microcomputer in the classroom with pupils with moderate learning difficulties.

All these projects provided the Region with a good network. Contacts with national bodies, including the CALL Centre in Edinburgh, and support from local establishments and personnel allowed information to be disseminated quickly across the Region (see Fig. 1).

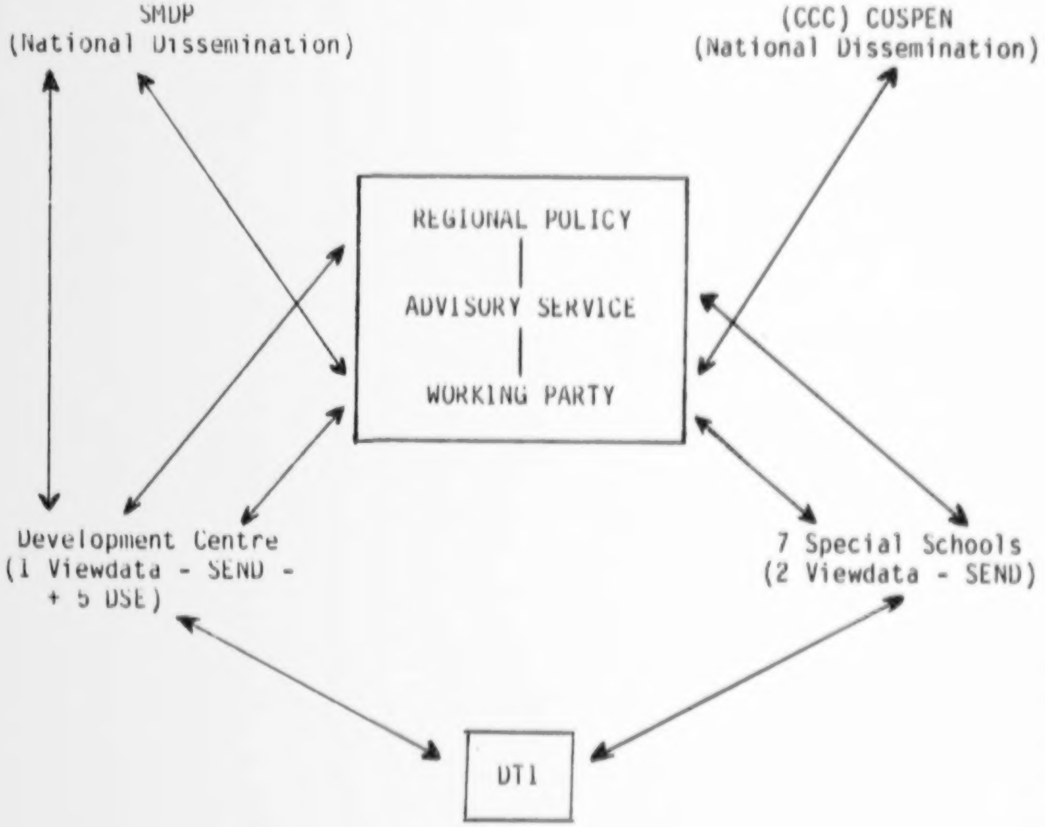
SMDP
(National Dissemination)
(CCC) COSPEN
(National Dissemination)
REGIONAL POLICY
ADVISORY SERVICE
WORKING PARTY
Development Centre
(1 Viewdata - SEND -
+ 5 DSE)
7 Special Schools
(2 Viewdata - SEND)
DTI

Figure 1

Note:

CCC	Consultative Committee on the Curriculum
COSPEN	Committee on Special Educational Needs
DSE	Departments of Special Education
SEND	Special Educational Needs Database
SMDP	Scottish Microelectronics Development Programme

There were a number of successful outcomes from this work. These were noted under the following headings:

Hardware: As a result of the joint initiatives and forward planning, the ratio of microcomputers to pupils is greater than 1 : 10; in some schools it is as high as 1 : 5. The benefits of this level of resourcing are reflected in the increased skill level and relaxed attitude towards computers of both staff and pupils.

Software: Staff from schools across the Region were involved in evaluation, modification and development of software, which encouraged the skills required in the specification and designing of new pieces of software.

Management: Schools were well equipped with adequate equipment and appropriate trolleys to encourage portability and easier organisation and management. Support was given by Advisory staff for both disk and equipment management. There were opportunities to exchange ideas at Working Party meetings.

Development Work: As a result of the initiatives, a programmer had been appointed to help with the development of software. This allowed a number of programs to be individually adapted to meet special needs and also enabled the development and specification of new programs to take place.

The increased confidence of staff and pupils over the period of the projects allowed new pieces of hardware and software to be tried and tested, identifying items which were successful with the pupils.

Support: Support was given to staff through the Advisory service, and through meetings with colleagues they supported each other.

In-Service Training: In-service training was provided in the Development Centre for staff within Fife and also offered to staff from other Regions. The majority of training was school-based and attempted to respond to individual specific needs.

As well as the benefits being identified, a number of gaps in provision and, therefore, needs were also highlighted during the years of the various projects, specifically the need for:

i) continuity of resources and provision after leaving school

ii) appropriate provision for pupils with severe communication difficulties and severe physical disabilities.

iii) a multi-disciplinary approach towards assessment to ensure pupils' needs are matched with appropriate resources.

iv) discussion across disciplines, with respect to technology, to look at its application to people with special needs.

It became very clear to the Region that, if development was going to continue and young people with special needs or particular handicapping conditions were going to benefit, there needed to be:

- clear statements of policy on provision of microcomputers;
- easy access to hardware and software;
- a steady flow of information - going both ways!
- support for the teachers, including meeting other teachers;
- a planned in-service training course;
- improved identification and assessment procedures;
- a raised awareness and a working partnership across agencies;
- links with and knowledge of other developments across the country;
- continued interest from outwith the Region.

This has led the Region to set up a small project, namely the Fife Assessment Centre for Communication through Technology (FACCT) which it is hoped will help individuals whose communication disorders are so severe that they seriously affect their quality of life and their access to learning. It aims to develop Assessment Techniques and help to provide networks in which the main support services of the Health Board, Social Work Department and Education Departments can work in a coherent and structured way for the benefit of the individuals concerned.

Over the period of the previous projects, it has been difficult to estimate the relative influence of either strand: whether the local momentum could have been maintained without the additional resources from outside, or whether an external initiative could succeed without a well-established existing development programme.

Fife has a well-established development programme, with the FACCT Project being one of the major strands, as well as a number of areas being explored by the re-established Working Party. However, it is reassuring and very beneficial to have continued interest and support from agencies outwith the Region.

EXPERIENCES OF THE TURTLE

Agnes N Bruce

Rosslyn School, Fife, is a Special School for children who are ascertained as being in need of special education because of the severe degree and complexity of their handicapping learning disabilities, such as retarded development in language and speech, motor skills, perceptual abilities and attentional skills, where there may also be present, in varying degrees of severity, physical handicapping features.

In addition, the children may, and usually do, have blocks to learning caused by personality and social behaviours such as sudden swings of mood, hyperactivity, ritualistic mannerisms, catastrophic reactions, acute distractibility, not to mention aggression, insularity and severe lack of self-help skills.

Many techniques and strategies are employed to help each child overcome his or her difficulties and to promote a favourable background for the child to make gains in the processes of learning. Much effort and skill is used by teachers in such schools. These teachers have constantly to augment their own information banks and draw on their own ingenuity in order to help the child accomplish and make gains in understanding, and being part of, the complex demanding world in which they play a part.

Among other types of special aids used by teachers there have been such devices as touch tutors, possum machines, language masters, etc. - aids specially designed for special school pupils. It is into this background that the floor Turtle, driven by a microcomputer, was introduced. It must be stressed that this Turtle was not designed for the pupil populations of schools such as Rosslyn - on the contrary, it would seem that Turtle was designed quite uniquely to bring into Education an opportunity for pupils to investigate and explore for themselves the many and varied routes to the acquisition of knowledge. That this same Turtle could be used in Special Schools posed questions to and excited areas of teaching and learning that could not be ignored.

Turtle was seen here initially as a visual/motor tool that presented a learning aid that had very positive features - it was impersonal, its size was not threatening, it was mobile, it could draw, it behaved consistently regardless of atmosphere and environment, it passed no opinions, it made no judgements, it always made the same responses, it was tireless, it made no demands and it always obeyed commands.

Moreover, it worked in a set space - a large white board on the floor (8' x 4') which presented a bounded attention area. No concept keyboard was available but the regular keyboard was neat and well placed in relation to the visual screen of the microcomputer.

Rosslyn School, Fife

The temptation to involve the most able child in the school was resisted. The thinking on this was decided by the fact that this was a trial where the Turtle had to be viewed as being for general use throughout the school, all difficulties notwithstanding. The child had to be one who would typify most other children in schools such as Rosslyn.

Alan was aged 10 years and was chosen to be the first user. He had many problems: brain damaged; language and speech retarded (his receptive language much less retarded than his expressive language); his IQ score on the Stanford-Binet (L-M) Scale was approximately 35-40; some spasticity; some autistic features (ritualistic hand, head and foot movements); hyperactive (mostly when in "free" situations such as music, movement and crafts); aggressive and destructive when thwarted, frustrated or bored; poor attentional skills; poor fine and gross motor skills; faulty spatial concepts; disruptive; was given to catastrophic reactions to personal attention or involvement; poor co-ordination in mobility; at this time no 'reward' system had been useful.

But - he liked machines, tape recorders, switches, nuts and bolts, etc.

And despite - his motor disabilities, he had rough but useful manipulative skills with such apparatus.

And - he could act on his receptive language instruction.

These last three statements were the positives upon which the view of the Turtle would be assessed.

Alan's teacher had no previous experience of either a microcomputer or a Turtle. Her introduction to them was short and hurried and had more to do with assemblage of the parts involved than with the performance or philosophy. This was not, in retrospect, a bad thing since both Alan and teacher had to direct their shared attention to the one focus.

Initially she showed Alan the Turtle. He had approached the trolley and apparatus with obvious interest. He listened and looked, standing still, exhibiting no other behaviours other than those of attention. He also showed interest in the cables, the Turtle interface, the screen, etc., so the teacher just talked him through the assemblage. The teacher had a collaborative approach with Alan - he sat by her side while she loaded the cassette recorder - she explained what she was doing demonstrating in an incidental manner the sequence of the routine. (When she made mistakes he laughed in a conspiratorial manner!)

He watched attentively the sequence of the one key press activities and the subsequent movements of the Turtle. He left the initial introduction reluctantly but with no adverse behaviour being exhibited. The teacher, on the basis of his attentiveness and interest, made decisions about subsequent sessions.

It was decided then that no adjustments would be carried out in order to accommodate Alan's difficulties but rather Alan would be encouraged to accommodate the apparatus by attempting to change his own behaviours. The teacher noted the keyboard sensitivity, the number and closeness of the keys, the fact that Alan could not 'read' the letters or numbers, etc., but once again the decision was made to make no real concessions - that the difficulties would be met as they occurred. In the meantime, the teacher was herself learning about the microcomputer and the Turtle.

Alan had, over 11 weeks, about 20 hours work on the Turtle. During this time he: maintained his attentive interest; accommodated his finger pressure and fine motor movements to the keyboard; made a close personal relationship with his teacher; used more expressive language; volunteered help in loading the cassette recorder; recognised U.D.R.L.F.B.H. RETURN space bar ...... plus the ESCAPE and BREAK keys! (Those last two were sources of mischief rather than of "bad" behaviour); learned to attend to three areas of activity - the screen, the keyboard and the Turtle; learned the 'sequence' of events; made decisions on what he wished the Turtle to do; stated the shapes that had been drawn, e.g. ("It looks like a house", "It is a square, circle, etc."); showed an awareness of directionality: "turn", "to this side", "to that side", "forward", "back", "too far", "off the board", "round and round", etc.; maintained good posture, gait and demeanour, exhibiting no bizarre or ritualistic movements; reduced his distractibility; showed no catastrophic reactions; maintained an even tolerance; showed a desire to be doing more; called up procedures viz. S for square, TR for triangle, TRA for trapezium, RO for rocket, HO for house, ARC for arc, CIR for circle, CU for cube, RH for rhombus.

The view developed within the school was that the Turtle should be introduced to the very youngest of the children so that the benefits could be made use of as early as possible and so that there would be a kind of parallel development taking place preventing gaps widening for a child whose skills were already retarded.

Some interesting, expected and unexpected observations have been noted. The Down's Syndrome children working with Turtle did not, as expected, generally exhibit as many visual perceptual difficulties as some other children. Their work therefore with Turtle was more adventurous but they were less patient with the initial steps of manipulation and there was not much marked behavioural changes. What was noticed was that the Down's Syndrome children had more specific expectations; in other words, they were not surprised at what they had achieved!

Two hyperactive teenage girls, who had fair expressive language skills that were not really well used, worked for a total of about two hours with Turtle. The results here were unexpected, for the girls had not previously shown much directional or spatial skill ability. Both showed great aptitude in getting the results desired through using the concept keyboard where the measured distances were not sufficient. Between them they came to the conclusion that they would use "units" of forward and backward movements in order to make their lines longer. This meant a great deal of interactive verbal communication. Their teacher was amazed by their fluency as well as the facility of their use of a new vocabulary and the speed at which they built a repertoire of new language constructs.

A more able boy aged 10 years who had highly distractable behaviours and who used his language skills in a most disjointed and non-sequential manner paid instant and interested attention to the Turtle activities. With no obvious difficulty he moved through his initial introductory stage with no more effort than any other boy of his age. All the while he interspersed his actions with very relevant and cogent statements and questions, the answers to which he acted upon. Many of his activities highlighted abilities that were not previously attributed to him - indeed he had been regarded as a boy with many spatial difficulties. What did emerge though, was that he had quite a marked deficit in visual closure skill. However, by the end of two sessions he was recognising that he was not completing a shape-making task but finally made extra effort to do so.

Turtle work with children who have additional physical disability is without exception extremely useful to them. 'Delight' is not generally speaking a term used in educational circles but the obvious delight of these children in producing movement by Turtle, commanding it to move, stop, turn, etc., is most uplifting and there again is no doubt that future more cognitive progress will be made by these children. A straight line commanded by one boy was the highlight of his day. He decided its length and direction and he produced a most satisfactory result for himself. Those who were observing saw evidence of his excitement and desire to do more, and perhaps more importantly, he wanted to know more about the complicated drawings.

The Nursery Class children in this school are the children who will benefit most since they show evidence of overcoming conceptual and behavioural difficulties while these are as yet not significant blocks to learning. The gaps in many areas of their acquisition of certain skills will not widen and their concepts will be enhanced much sooner than could be expected through other strategies.

Initially the Button Box was used instead of the microcomputer, but since the acquisition of the concept keyboard the children are using this with a fair amount of developing ability. As yet, the Turtle is not being used with its pen. The young children from four years to six years more or less play with Turtle - stopping, forwarding, backwarding, turning, etc. The sound Turtle emits on stopping is somewhat of a 'wrong' reinforcement but it is too seductive to be eliminated at this stage!

It is agreed by all teachers involved with the 'turtling' that the usefulness of Turtle as a learning tool, while only being tentatively approached at this time, opens up all manner of possibilities in this particular area of education. There are indications that the children will 'grow' with Turtle.

COMPUTER TOOLKITS IN SPECIAL EDUCATION

J.P.Odor*

ABSTRACT

Modular software tools and common user interfaces have much to offer special education, especially in reducing the problems a child (and sometimes a teacher) has in understanding complex modes. Examples are given of mode-free toolkits used in the design of a Smart Wheelchair, and in an Assessment kit for tailoring communication aids. Toolkit metaphors are outlined. The multiple control and learning tasks for a handicapped user of computers is related to potential toolkit metaphors available to designers. The case is made for common operating systems of a power sufficient to support those metaphors requiring advanced features like multi-tasking.

INTRODUCTION

The motivations behind the use of a 'Toolkit' approach to creating and using software include those of sharing and reusing expensive to produce program components; easing the users' tasks in tailoring systems to their own needs; and, most importantly for special education, the production of 'mode-free' systems.

A shared experience between special educators and those using microcomputers for enhancing impaired communication is that of controlling complexity. The creation of individualised computer-based curricula and the design of tailored communication systems both involve using software which defers many design choices until they can be decided by the user. These choices range from specific topic content to display and control strategies. One often used approach is to offer several modes of operation, each with different characteristics, and sometimes with the facility to shift between them (such as in a word-processor with, say, a file handling mode and several levels of editing commands). This in turn makes learning more complex for the pupil. He or she now has to learn, as well as the actual task, a constellation of features bestowed by the mode on his or her computer system, which usually have control mechanisms bearing only a tenuous relationship to the actual function. The next mode will provide a confusingly different set of functions for the same controls. A related problem arises when several distinct programs are in use, each with a different approach to the user interface.

It was partly a reaction to the mode problem which inspired Xerox Parc workers to create the SmallTalk system, with its particular brand of object-orientated mode-free programming tools. A single tool corresponds to a unique function, with no inbuilt control hierarchy. Mode-free toolkits, in contrast to moded systems, try to provide close and clear coupling between controls for the set of tools in use and the required functions. In an idealised toolkit, it should be possible to select as few or as many active functions as needed for the current task. Understanding how a tool operates alone should be sufficient for a user to infer how it will interact with others. In practice, this divisibility into independent tools is hard to achieve, and depends in part both on the metaphor in play, and the user interface chosen.

Using a system involves having a mental image of what goes on in the machine. A Toolkit Metaphor is the designer's plan for what this mental image should be in the user. To take a simple example, the user of a painting package thinks in terms of handling specialised drawing tools, one at a time, and the metaphor is close-coupled by the icons and pointing tools involved. In contrast, the user of an online spelling checker has a notion of using two tools at once: a typing tool, and a concurrent spelling tool, forever hovering in the background. The actual form of the metaphor is normally determined by the task. However, for special education, one must also ask to what degree the metaphor is comprehensible to the child. Since an inability to handle complex multiple learning tasks is one of the characteristics of many children in special education, the chosen system needs an overt, consistent metaphor which can itself be taught, perhaps independently of any particular topic.

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All this points to the need for mode-free designs with consistent user interfaces. Two of the projects in progress in the Communication Aids for Language and Learning Centre in Edinburgh University will serve to illustrate the approach, before returning to what forms of toolkit and user interface are available to designers.

EXAMPLES

The Smart Wheelchair

For a physically handicapped child, learning experiences are much curtailed. We wanted to provide a learning environment which would encourage mobility and exploration, teach communication skills, give access to Computer-Based learning, and allow play. We built a computer-based extension to an electric wheelchair to achieve this. The Smart Wheelchair allows a child or adult, using the same set of inputs (of which there are many options, ranging from single switches up to proportional control), to operate a communication aid, control external computers, and drive the chair. On-board sensors allow the Chair to take varying degrees of responsibility, depending on the learner's needs: in an extreme case, the rider can explore safely using a single switch. The Chair can also be controlled by external computers; or by the learners own communication aid.

With such a rich collection of facilities, it was tempting to present the Wheelchair as a moded system: indeed, our early designs described 'mobility' 'communication' and 'turtle' modes (the chair can act as a Logo sit-on Turtle). When it became obvious that the setup procedures for modes and submodes were becoming unwieldy, we redesigned the system as a collection of tools, essentially any mix of which could be used together. Some 'belong' to the chair (like Look-ahead tools for avoiding objects, 'Line-follower tools' for tracking lines on the floor, and 'Bump tools' for handling emergencies). Some 'belong' to the user, like the choice of input,-ranging from a single 'Go' button, through switched and proportional 'Steerers', to scanned matrix selection systems with macros, and external communication aids. All tools are active whenever selected (or in the case of those owned by the learner, whenever plugged in). The prototype is now being evaluated in an Edinburgh special school.

An Assessment Toolkit for Communication and Learning Impairment

The range of issues which has to be addressed by the provider of a communication aid is very large, encompassing mode of control; vocabulary; output mode; and the language capabilities of the learner. Assessment is a process of observation and manipulation of system variables which can take many months: if the system is produced for a child, then assessment takes place continuously with development and change over several years. Manipulating the variables (e.g. tailoring the system) is thus a major activity. We have been designing a mode-free toolkit for assessment , which, given a little luck in the future power available on cheap laptops, could also evolve into a practical basis for designing and building actual communication or writing aids.

A communication aid (and, often, a writing aid) can be factored into distinct components which can then be brought together as needed by the communication impaired person and their helpers. Components include input systems (again, as with the Smart Wheelchair, ranging from single and multiple switches through pointing systems to direct selection via keyboards and the like); vocabulary handling aids such as thesauri, spelling checkers, pre-stored phrases or word/symbol-banks, and predictors; and output systems like screen displays of text, icons, pictographs, and animations, speech, music, and control of external devices. In addition, feedback to the user may take a different form to that required by the communicatee.

Our assessment toolkit consists of a collection of such software and hardware components, designed to a common standard, which can be connected together by the therapist in a complementary stream of processes between input and output to form an easily changed, bespoke communication system. The processes are similar in form to a Unix Pipe, (and are therefore known as a Pipe toolkit), although they are currently being developed in Logo, or LogoWriter, to allow the ideas to be tried on simple microcomputer systems.

TOOLKIT METAPHORS

It can be seen from the examples above that a toolkit can take many forms, each of which needs to be understood by both creator (the teacher or therapist) and user (the pupil or communication impaired person). We have identified several metaphors. The Pipe metaphor used in our assessment toolkit selects from complementary tools which act in sequence upon an input command, progressively modifying it until an acceptable output is formed, with feedback and monitoring functions performed en -route. In contrast, the tools in the Wheelchair are demons which are all active all of the time, each responding to its own range of inputs to perform its own functions. A similar position is held by concurrent spelling checkers. Other metaphors include the class of tools which are omnipresent, but selected and activated by the user: the Paint programs are a trivial example.

The particular metaphor used is conventionally determined by both the function, and the available user interface. We argue that for special education, it is also important that the metaphor ought to be chosen to be transparent to the user: that it ought to provide the basis for predicting what the system will do, and analysing what it has done, in any given circumstance. We call this characteristic the metaphor's ability to provide an 'Audit' of its actions.

To summarise: three advantages spring from the use of toolkit-based, mode-free designs for special educational software. The first is the ease with which such systems can be tailored. The second is the potential for transparency of use for the child. The last comes from the fact that there are identifiable classes of toolkit metaphors. Since this is the case, it becomes possible to evaluate and comment on their effectiveness for special children in a way not possible with the more amorphous moded systems.

Since the design of a suitable Metaphor cannot be separated from the design of its user interface, I now turn to the problems and possibilities of generating such principled, coherent designs on afforable computers in the near future.

FUTURE DEVELOPMENTS

Research Issues

A handicapped learner using a computer-based system faces a multiply-layered control and learning task. Above the layer to do with the concepts to be learned is the presentation layer: how are the shapes on the screen, or the sounds from the speakers to be interpreted as representing, say, number, or time, or money? The designer hopes for a transparent morphism between concept and representation, but this still has to be learned by the student: it is at one remove from reality. On top of this is a layer of control functions to be learned: what happens in this program and now, when a given key is pressed?. Where should one look for control cues? Again, the learning task is additional to the basic concept, and (given the confusion of approaches in differing programs) may be more complex to learn than the actual task. The final learning task lies in understanding the tools / modes metaphor currently in play.

Although we believe that a modeless system forms an easier learning task than a many-moded system (or many, different, single moded systems) , it is currently not clear which metaphors are right in which circumstances of learning difficulty and task. We hope that our work on the Smart Wheelchair and the Assessment Toolkits will help our understanding of the learning tasks involved.

Questions about toolkit and user interface appropriacy cannot be resolved by individual program designers, each exploiting a raw computer in idiosyncratic ways. There must be consensus about approach, and the best way to achieve this is through the provision of common design tools and

environments, which I turn to next.

The Need for Standards

Transfer of hardwon experience is vital to the special learner. Irrespective of the appropriate toolkit metaphor, evolution toward a common user interface will be a vital step. Requirements will be different to those for able users. The most common mode of learning failure in special children is reading and writing conventional texts. The user interface should therefore provide a rich set of alternative interaction modes : pictorial, animation, iconographic, speech, pointing, and others. Some of the WIMP shells move toward this ideal, but need extension.

Toolkits rely on advanced computer features to sustain the images of their metaphors: real or apparent concurrency, arbitrary combinations of components acting on common data, immediate piping (ie, Unix-like rather than MS-DOS like) and so on. Most of all, they rely on the acceptance of common standards for software production and interfacing.

Interface Standards have received international attention recently, and there are indications that a common approach has been defined which is acceptable both to industry and users on both sides of the Atlantic, to the point where American legislation requiring computer manufacturers to adhere to these standards looks likely.

The service requirements for software production could be achieved through adoption of a common operating system of reasonable power, extended through appropriate shells. However, special education (indeed, UK national education) has neither the coherence nor the market base to define its own standard. Educational policy-makers should instead adopt a commercial system, supported by a broad industrial base, putting central development resources into shell extensions, the production of tools, and appropriate training. There are currently few signs that this nettle has been grasped other than in guidelines designed to benefit local industry: recognition of the need for advanced systems for handicapped children seems scant.

PROLOG AND COURSE ADMINISTRATION

M.A. Stone*

INTRODUCTION

The majority of teachers in Higher Education in the UK are likely to have experienced a considerable increase in the demands placed upon them by course administration over the past few years. In part this is due to the increased student numbers in the system and in part, and perhaps more importantly, by the increasing complexity of the courses themselves. This effect is particularly acutely experienced with the development of Modular and/or Credit Accumulation schemes. Such schemes are designed to be student centred in that they place few restrictions on the combinations of courses that can be taken together. Thus each student entering such a scheme can tailor their personal study plan to their specific requirements. The effect of this is to create a bewildering number of feasible and allowable individual study plans and a large administrative burden to go with them. This paper is based on the anticipated administrative problems of one such course, the Combined Studies Programme at Lancashire Polytechnic.

The Programme is deceptively simple consisting of an extensive Catalogue of courses (approximately 600) and a compact set of Regulations which relate to progression on the course, the requirements for various types of award (Honours, Degree, Diploma), the classification of these awards and the rules which must be satisfied before a 'named' degree can be obtained (e.g. Major Psychology/Minor Computing). The problems in administering such a Programme resolves itself into a set of questions examples of which are as follows:-

> Which students have elected to take my course?
> Can this proposed study plan be taken given the timetable?
> How can we timetable the examinations for the Programme to avoid any clashes?
> How can we be sure that we have advised students adequately and made them aware of various possibilities open to them?

It is almost automatic that one should look towards some form of computerised administrative system to manage these questions. In this case the author has begun to develop a system based on the programming language PROLOG. The system is being developed using the implementation of PROLOG described by Clocksin and Mellish (ref1) within the University of Sussex POPLOG system on a VAX 11/760 computer.

THE ADVANTAGES OF PROLOG

PROLOG is a logic programming language and is the best implementation of first order predicate logic that is widely available. PROLOG has the following advantages:-

1. Information can be represented in both declarative and procedural forms.
2. Information can be stored in implicit form which can be derived by the use of procedures.

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3. PROLOG is modular allowing declarations and procedures to be added or deleted without disrupting the system as a whole.
4. Programs can be developed on a "top-down" basis.
5. The programs are structured and consequently easy to understand.
6. PROLOG encourages object-orientated programming.
7. There is growing expertise in the development of logic programs.

The declarative form may be used to establish a database of facts which could include such things as student records, student study plans (the list of courses they wish to take), the class timetable, teaching and/or examination rooms and their capacities etc.. Each of these sets of facts can be treated as a data structure or object.

The procedural form can operate on these data structures to generate new data structures; in other words to derive new facts. For example, one can take the student study plan data structure and derive a new data structure which lists the students taking each course. Additionally, one could take the study plan structure and class timetable structure and operate on them with a set of procedures (or rules) to determine if each of the individual plans are feasible.

The remaining sections of this paper will be concerned with giving examples of use of PROLOG. Inevitably this will mean simplifying the problem. Nonetheless it is hoped that it will give the reader a sufficient feel for PROLOG and its potential to encourage further investigation.

A SIMPLE DATABASE AND RULE SYSTEM

PROLOG allows one to translate simple facts directly into a database. For example consider the following:-

```
     study_plan(adam,[ps2_1,ps2_2,ps2_3,fr2_1,fr2_2,fr2_4]).
     study_plan(bert,[ps2_1,ps2_2,ps2_4,fr2_1,fr2_2,fr2_4]).
     study_plan(chas,[ps2_1,ps2_2,ps2_3,1a2_1,1a2_2,1a2_4]).
     study_plan(dave,[fr2_1,fr2_2,fr2_3,1a2_1,1a2_2,1a2_4]).
```

Each of these is a PROLOG clause which has two components, a predicate and its arguments. In this case the predicate is a STUDY_PLAN which takes two arguments, the first is the name of the student (e.g. adam) and the second is the list of courses ([ps2_1,ps2_2,.....,fr2_4]) which adam is studying. Translated into English it simply states that adam has a study plan containing the following lists of courses.

We can interrogate the data base by asking the following question:-

```
     ?_study_plan(adam,List).
```

PROLOG deals with this by looking through its database until it finds a predicate STUDY_PLAN with two arguments. It then continues to search until it matches the first argument - adam and instantiates the variable - List to adam's study plan. Note that constants are written in lower case and variables begin with a capital letter. PROLOG then replies:-

```
     List - [ps2_1,ps2_2,....,fr2_4]?
```

this being adam's study plan and invites a further enquiry with a '?'.

If one responds with a ';' then PROLOG resumes its search through the database looking for other STUDY_PLAN predicates with adam as the first argument. If it can find none, as it would in this case, it replies 'no'.

We might then want to ask which students are taking a specific course. Effectively this means that we should examine each student's study plan and determine if that course is in the list. There is an easily defined predicate MEMBER (take this on trust) which can do this.

Our PROLOG rule could be phrased as follows:-

```
     course_student(Name,course(X)):-
             study_plan(Name,Course_list),
             member(X,Course_list).
```

Addressing our database with the enquiry:-

```
     ?-course_student(Name,course(ps2_1).
```

Would elicit the responses:-

```
     Name - adam?;
     Name - bert?;
     Name - chas?;
     no
```

Now we can go on to define the predicate JOINT_COURSE_STUDENT as follows:-

```
     joint_course_student(Name,course(X),course(Y)):-
             study_plan(Name,Course_list),
             member(X,Course_list),
             member(Y,Course_list),
             X /= Y.
```

Thus two MEMBER predicates must be satisfied and note that we have further specified that the courses X and Y must be different with the clause X /= Y.

In practice it would obviously have been better if we had combined the individual study plans into a single list or data structure:-

```
     study_plans(cohort(1988),
             [[adam[ps2_1,ps2_2,ps2_3,.....]]
              [....[.......................]]
              [dave[.................,1a2_4]]]).
```

This would facilitate the passing of the data structure to other procedures.

```
     ?-study_plans(cohort(1988),List).
```

Would instantiate the complete set of study plans to the variable List.

EXAMINATION TIMETABLES

We now have the basis for writing a set of rules for generating an examination timetable since the essential requirement is that no two examinations that are to be taken by the same students can be timetabled together. Thus given a list of examinations we could devise a set of predicates that would place two course examinations on the same session provided we can satisfy the following predicate:-

```
     not(joint_course_student(.....)).
```

Of course there will be other predicates to write, for example we will need to ensure that there is adequate space to accommodate the examinations. We could therefore define and EXAM_SPACE predicate which would also need to be satisfied:-

```
     exam_space(course(X),number(N),session(S),location(L)).
```

This in turn would require a list of rooms in the database together with each room's capacity:-

```
     room(location(R),seats(Seats)).
```

Finally we would need to write a rule to satisfy EXAM_SPACE. I am not sure exactly how this would be done but I am confident that there is a logical solution and hence it can be specified.

Further constraints could be added to the rule, for example a frequent student complaint is that they have examinations in adjacent sessions. To avoid this we would need to write a clause which succeeded if this happened, negate it and add it to the rule base for the examination timetable. From this discussion one can appreciate the modular nature of PROLOG and the way it encourages the 'top-down' approach.

CONCLUSIONS

PROLOG then will operate on a database to produce new data structures which go beyond the capacities of most relational databases. Insufficient space precludes the description of further applications. However it would be possible to write most course regulations in PROLOG. Indeed well formed examination regulations are easily translated into first order predicate calculus and thence into PROLOG. The reader is referred to the work of Sergot et al. (ref2) on translating the British Nationality Act into a Logic Program for a further discussion on this related issue. Further there are many problems which do not have definitive solutions. For example advising students on their study plans is not simply a matter of proving that it can be timetabled and that it satisfied the course regulations. Students will have objectives which are less easily defined and require careful advice, in relation to their likely success, employment and long term financial rewards. This application, probably the most important of all, have the flavour of an expert system and here the link with Artificial Intelligence should beexploited. PROLOG has the advantage that it can potentially combine all of these functions into a single unified system.

REFERENCES

1. W.F. Clocksin & C. Mellish, Programming in Prolog, 2nd Edition Springer-Verlag (1984)
2. M.J. Sergot et al., Communications of the ACM, 29, 370-86, 1986

CONSISTENCY IN GRADING COMPOSITION ACROSS THE DISCIPLINES USING AN ARTIFICIAL INTELLIGENCE PROGRAM

D.M. Williams*, N.R. McGee+

ABSTRACT

Fifty research papers written by students in a private technological university were analyzed by computer text analysis programs to determine the consistency of grading among faculty in writing courses and content area courses. Elements and characteristics of the writing revealed by text analysis were examined to determine grading predictability. Consistency of grading was found to be significantly different within writing classes and across the disciplines. The single significant predictive characteristic regardless of writing assignment or instructional environment was the readability index of the paper.

INTRODUCTION

With increasing writing requirements in all subject areas of the university, the problems of achieving consistency in grading practices have been emphasized. Since students are receiving writing instruction in such courses as Technical Report Writing (TRW) while concurrently producing similar papers in content area classes with no writing instruction, the issue of writing assessment takes on significance of providing appropriate formative and summative evaluation in differing writing environments. This study examines two aspects of the problem: does the trained teacher of writing grade with more consistency and measure the same elements of writing as does the content area teacher for whom the written product represents mastery of the course content rather than writing,and what are the characteristics of successful writing commonly recognized by both groups which can be considered predictive of grading outcomes. By using computer text analysis programs to examine papers graded by both groups of teachers, this study sought to define current practices in grading and identify the elements and characteristics of writing important to both groups of teachers.

OUTLINE OF STUDY AND METHODS

The papers analyzed were written by sophomore, junior, and senior level students at Embry Riddle Aeronautical University, a private technological university emphasizing training for careers in aviation. The university is located in Daytona Beach, Florida. A random sample of 303 research papers assigned and graded by professors teaching the required Technical Report Writing course and by professors of courses in Aeronautical Engineering, Aeronautical Science, Computer Science, Aviation Business Administration, and Aviation Management was collected. Initial analysis of the 303 papers by Right Writer, a C-based artificial intelligence text analysis program designed to assist technical and business writers, yielded a final sample

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of 50 papers (1100 pages of text). Since students are not prohibited from submitting papers written in TRW class to fulfill requirements in content area classes as well, the sample includes ten identically matched pairs. The 50 papers include 25 from TRW representing five each A, B, C, D, and F papers and 25 from the content areas names above with the same grade distribution. The sample papers were then subjected to the complete *Right Writer* analysis of the following elements: word count; readability index based on the Flesch-Kincaid model; the strength index, a style evaluator; the descriptive index, a measure of modification; and the jargon index, a measure of non-standard English forms.

For comparison, the papers were also analyzed by *PC Style*, another C-based text analysis program which additionally checks personal tone, verb use, and presents a graphic evaluation index.

To determine the relationships of each or all of the nine variables derived from *Right Writer* and *PC Style* to instructor-assigned grades, a variety of statistical techniques were implemented. Following basic analysis of the data with APP-STAT, a statistical program yielding the initial descriptive statistics, the data were entered into the SPSS-X (Statistical Package for the Social Sciences) program on an IBM 4381 for additional analysis. Procedures included frequency distributions with histograms, a one-way analysis of variance, and a multiple regression study of the data, Pearson Correlation Coefficients study, and tests for the homogeneity of variances.

RESULTS

In comparing TRW instructor-assigned grades with those assigned by content area instructors on identical papers submitted in two or more classes, the grades were consistent 62.5 percent of the time, having a range of variation of only one letter grade in all inconsistent cases.

Across the disciplines on identical papers which were submitted in two or more content area classes, instructor-assigned grades were consistent 75 percent of the time with a range of variation of only one letter grade in all inconsistent cases.

In papers which were submitted in two or more TRW classes, the instructor-assigned grades were consistent only 50 percent of the time with a range of variation from one to four letter grades on identical papers. None of the text analysis scales correlated highly with these variations in evaluation because of the consistency of the programs, unlike the instructor evaluations.

Analysis of the data revealed that the mean score of the *Right Writer* readability index for the sample was 10.9. A score of 6.0 to 10.0 is considered by the authors of the program to be acceptable for writing of the type found in the sample. The correlation between the grade assigned and the readability index proved to be .33, one of the highest individual variable correlations.

The mean of the *Right Writer* strength index for the sample was 0.06. The recommended score is 0.50 or higher. Closer examination of the data revealed that 46 percent of the sample papers received strength index scores of 0.00 accounting for the extremely low mean.

The mean of the Right Writer descriptive index for the sample was 0.55. This score falls in the middle of the prescribed range of 0.0 to 0.9, an acceptable position. However, correlation between the descriptive index and instructor-assigned grades was only 0.06.

The mean for the Right Writer jargon index was 0.136. The program prescribes a range of 0.0 to 0.5, with 0.0 being acceptable and 0.5 containing too much jargon. Examination of the data revealed that 48 percent of the papers in the study scored 0.0 on the jargon index despite the highly technical nature of the material contained in some of the papers. Correlation between the jargon index and assigned grades was .27.

In order to assess the performance of Right Writer and compare its indices with another program, PC Style, a second text analysis program was used. This addition expanded the number of indices in the study from four to nine. Of the scores on the various indices, the readability indices from the Right Writer program and from the PC Style program proved to be the most highly correlated with instructor-assigned grades with correlations of .33 and .50 respectively. The data revealed that 82 percent of the sample papers which had readability levels of 9.8 or below received instructor-assigned grades of D or F. When the readability level fell to 9.21 and below, 83 percent of the sample papers received an instructor-assigned grade of F.

A multiple regression study of the various factors revealed that no single index from either of the text analysis programs used in the study could serve as an adequate indicator of what grade would be assigned to a paper. The strongest indicator of correlation throughout the study proved to be a combination of all of the indices used as a predictor of assigned grades. With a multiple regression score of .64, the combination score surpassed any other combination of indices.

The computer evaluation programs analyzed in the study, used as intended, can increase consistency in both instructor grading and in student self-evaluation of research writing; however, the lack of correlation of any factor in the text analysis programs indicates that using the programs as the sole determining factor in grading is impractical. Refinement of the programs should rely on one of two basic approaches. Because of the relatively high correlation of the readability indices with instructor-assigned grades, refinements in the ability of the computer to analyze readability are indicated. Because the combination of all indices proved to be a better predictor of instructor-assigned grades, expansion of the number of factors evaluated by the computer could increase the likelihood that the text analysis programs would become more valuable evaluative tools in the field of technical writing.

TOWARDS AN INTELLIGENT CAL AUTHORING SYSTEM

P. J. Scott* & R. I. Nicolson.*

ABSTRACT

It is very difficult to provide adequate support to teachers who wish to produce their own Computer Assisted Learning software. The current generation of authoring systems lack the ability to directly apply the software-design expertise of human CAL-designers. The SCALD-1 system is an experimental program which aims to apply artificial intelligence techniques to the authoring process. It is discussed here as a prototype of some of the features which would be required of an "intelligent" authoring system for CAL. Currently, the SCALD-1 system can produce simple instructional and science-demonstration styles of CAL without any teacher-programming. It uses event-based authoring represented as CAL-scripts, which is potentially much more flexible than existing frame-based authoring and should extend naturally to some other CAL styles. It is currently implemented as a large prolog program on an RM Nimbus micro.

INTRODUCTION

The key to a higher quantity of reasonable quality educational software production lies in the development of support technology adequate to permit teachers to make use of the new technology within their existing curriculum framework. Whilst existing software tools offer to improve the quantity of software they often fail to produce quality material because they are unable to provide adequate support for the design process. Production by human teams is the only current mechanism that does provide this support and hence quality but is impractical because of its cost in terms of time, resources and cash. The success of team support lies in the role of the human CAL design specialist involved. The skills of this individual as an 'analyst' of the teacher's requirements in the design process are examined by Scott (ref 1) as eight sub-skills: the derivation of a mental-model, guidance on the pedagogical justification, assistance in defining initial requirements, actually generating a design, producing 'content' presentation teaching information in an appropriate form, anticipating potential problems, refining the design and finally tuning the product. An ideal production methodology would be to provide educationalists with access to a software CAL-design expert with some range of these skills. It is proposed that this expert could be implemented using existing artificial intelligence techniques to produce an 'Intelligent Authoring System'. We report on a prototype of such an IAS system called SCALD-1, the Scriptal CAL Designer.

Designs for CAL programs are represented in SCALD-1 as 'scripts' (ref 2), high-level stereotypical sequences of events. These scripts capture the common events which frequently occur in classes of CAL programs at various levels of detail. In this analysis, the process of design is conceived as refining these general events into successively more specific ones, according to the needs of the teacher. When it is refined, a script captures the structure and design of a particular CAL application which could be taken to a human programmer to be implemented in code. However, the SCALD-1 system can provide a Basic-code procedure for each element in the design which allows its products to be executed immediately.

Currently the system can produce a limited range of designs (and code) for CAL applications which can be classed as instructional or science-demonstration styles. These include for example, multiple-choice question and answer drills such as quizzes (ref 1), or simulations involving the illustration of one equation, such as the path of a projectile or the period of a pendulum, (ref 3).

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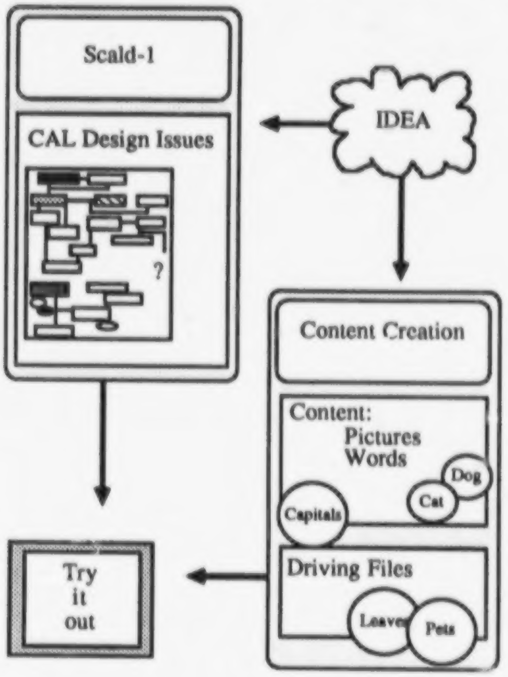
USING THE SCALD-1 PROTOTYPE

The SCALD-1 system interacts with computer-naive teachers, asking a series of questions about their needs, to provide them with a pseudocode 'design' for a potential CAL program. This design can be 'rapidly-prototyped' by the Scald system as a BBC-Basic program which may be executed immediately. The Scald system divides the design of a CAL application into two phases: the first generates the design for the 'logic' of the CAL presentation - the "how" it is to be controlled; and the second simply generates the 'content' which is to be presented - the "what" is to be taught. The latter is implemented as a suite of text and graphics processors with which the user produces the pictures and words that are to be used in the CAL presentation. The 'logic' of the CAL-design is generated for the user by an expert program implemented in prolog.

Figure 1 Logic & Content Creation in Scald.



This distinction is illustrated in figure 1. A teacher brings a vague initial idea to the system which can be initially developed in either phase. In the 'logic-creation' there are a number of design issues that must be considered - before SCALD-1 will produce a prototype design and program for the user to view. This program is usually "content-free" in that it sequences and presents instruction - but it gets the material to present from a separate source. This source is usually a "driving file" which contains a set of information about the 'content' that the user wishes to be presented. The main body of the driving file is references to other files which contain the pictures and words that are to actually appear on the screen, but these are also accompanied by other details - such as windowing information (ie. where the words and pictures are to go on the screen). For example, in the figure 1 the picture of a dog and the word 'cat' are stored in the driving file "Pets".

THE SCRIPT-BASED KNOWLEDGE REPRESENTATION

In SCALD-1 we represent CAL design knowledge as a special case of 'schemata' called 'scripts' (see ref 2). A **script** represents a temporal outline of a stereotyped event - for instance, a trip to the restaurant - in which the order of sub-events is important, and may be thought of as a schema for representing knowledge about events. The restaurant script is composed of a number of temporally-ordered sub-events (or slots, which may themselves be scripts) such as a 'going-to-restaurant' event, followed by 'eating-some-food', 'paying-for-meal' and 'leaving-restaurant' events. In attempting to refine this description it is necessary to provide detail for each event to some arbitrary degree of complexity. For instance the 'eating-some-food' event is clearly the main theme of the script and itself may consist of a script like, 'order-meal','wait', receive-starter', 'eat-food', 'receive-maincourse', 'eat-food', etc. The key to the script is that it provides a powerful representation for capturing the temporal ordering between and within events. As a datastructure for CAL this is very valuable as it will capture the 'teaching events' implicit in a CAL application. For example the basis of the "models" used in some conventional Authoring Systems, the instructional event of presenting a frame to a student, may be considered as a simple script of events such as; 'present the question', 'present the alternatives', 'get pupil response', 'evaluate response', 'react to response'. Unlike Authoring System models, however, the script may easily be enhanced by adding more sub-scripts, or, more interestingly, it can be incorporated as just one component of a much more complex script.

The task of the SCALD-1 design expert is to 'fill' an 'empty' CAL script, that is, to specify the values for all the script variables as simpler CAL events. Each variable will have a set of possible values (subject to various constraints) and the system will ask the user to choose an appropriate value. Typical decisions would be 'target computer hardware', 'type of material to be presented' - text or graphics etc, 'type of scoring', 'positive feedback', 'negative feedback', 'error contingencies' - presenting the question again immediately or later, presenting a hint; and so on. A full interaction could involve about 30 such choices, with the precise choices determined from the script and constrained by the previous answers. Each possible element with which the design expert may fill the script is constrained by a great deal of knowledge. The system relies heavily on the implicit knowledge that is present in the script data-structures.

The initial output from the system is a 'structured English' pseudocode notation which presents an informal design. However, each pseudocode primitive embedded in the design is directly related to a pre-defined piece of code in a 'code library' or 'software toolbox' and so, if required, the design may be automatically coded into BBC Basic using a simple implementation system.

STRENGTHS OF SCALD-1

The SCALD-1 system has not yet been fully evaluated, although relatively detailed informal evaluation has proved very promising. Nevertheless there are clearly a number of real strengths to this approach:

(i) Flexibility Unlike an author language, it is easy to add further components to a script, and so there is no problem in keeping up with progress in hardware, software or educational theory.

(ii) Portability The CAL-design language is relatively **machine-independent** and **language-independent**. So it is possible to implement the design in any language on any computer as long as it is possible to write a set of toolbox routines to convert the design primitives into the appropriate program code.

(iii) Rapid prototyping The program creation cycle has been collapsed. Program-logic design can take literally less than five minutes, and so the only real costs are the time taken for content creation. A text-based multiple choice quiz could be created from scratch within say 15 minutes.

(iv) The end of the power/training tradeoff Because SCALD-1 guides the author through all the necessary design decisions there is no need for the author to have a detailed understanding of the possible design options. Consequently it is possible to have an arbitrarily complex script which may still be used by a completely untrained user.

(v) Host-target development In general it is much more sensible to develop programs on as powerful a machine as possible, since these 'host' machines will have very much better program creation facilities than the much more limited target machines.

WEAKNESSES OF SCALD-1

Clearly, the current SCALD is a research tool rather than a commercial system and many of its present problems reflect resourcing priorities rather than any intrinsic limitations. Most can be remedied in the fullness of time, but several important problems with the present system should be noted:

(i) Lack of scripts At present SCALD has only 2 high-level scripts: for multiple-choice instructional script, and a science-demonstration simulation script, but we would like to offer many more possibilities. At present there is a disturbing lack of information about which designs would be most useful for innovative CAL applications.

(ii) Limited content creation facilities At present the content creation facilities available within the Scald system are simple text and graphics processors implemented in BBC Basic. Ideally, the system should have access to tools that are as powerful and as easy to use and the very sophisticated drawing, painting and even sound-processing software that exists for machines such as the Apple Macintosh.

(iii) Lack of course management facilities Some modern authoring systems allow the combination of several different programs to make a complete course, and provide record keeping facilities for the course as a whole - records of which modules each student has attempted, and summary statistics of their success. SCALD-1 has no such facilities at present, though there appears to be no particular difficulty in their implementation.

(iv) Inadequacy of the design language The current design language is an informal pseudocode which maps onto the corresponding BBC Basic procedure. A major priority is the development of a formal CAL-design language which has: (a) a formal syntax relating to primitives, arguments, flow of control, modules and scripts, (b) a greater range of primitives, and (c) global characteristics relating to desirable forms of user interaction.

CONCLUSION

It is suggested here that the key element of team production lies in the skills provided by a 'CAL analyst'. The main role of this individual (or group of individuals), is to provide support for the design and analysis of the developing idea. A full-scale IAS system would be expected to perform the whole range of CAL design skills of the human 'analyst'. The system SCALD-1 is an experiment to prototype some of these skills. Further research into the extension of the IAS concept will explore the development of scripts for other styles such as adventure-game formats, and more open learning environments. Clearly it it also very important to fully evaluate the utility of such a tool with specific reference to existing conventional authoring systems. The most obvious extension to the existing system is to better integrate the content-creation tools with the prolog-based logic-creation environment so that authors may readily interleave content and logic decisions leaving the system to enforce design elegance.

REFERENCES

1. Scott, P. J. SCALD-1 : Towards an intelligent authoring system. Unpublished PhD Thesis. The University of Sheffield. 1987.
2. Schank, R. C. and Abelson, R. Scripts, Plans, Goals and Understanding. Lawrence Erlbaum, NJ. 1985.
3. Gardner, P. SCALD-2 : The enhancement and evaluation of an intelligent authoring system. Unpublished PhD thesis. (In preparation). The University of Sheffield. 1988.

Acknowledgement : Some of this work was supported by a grant from the Economic and Social Research Council.

DISTANCE LEARNING - THE FORCES OF CHANGE

DR PETER A WALKER*

ABSTRACT

Developments in Information Technology will provide the means of introducing cost-effective Distance Learning into the eudcational and training environment.

INTRODUCTION

The development of electronics and information technology continues at a furious pace, and it is important that we consider how this technology may best be applied to education and training and in what form. In this paper I review the development of the technological push and the market pull that constitute the forces of change.

THE TECHNOLOGICAL FORCES OF CHANGE

The growth of the electronics and IT industry has resulted from the developments occurring in the semiconductor industry and the resulting ability of equipment and systems designers to incorporate increasing amounts of intelligence (ie logic and memory) into their products. Despite the phenomenal progress that has been made, it is expected that this trend will continue.

The Personal Computer

One consequence of these developments has been the emergence of the low cost personal computer now found in many classrooms and business organisations. The importance of the PC in the context of education and training is its use for Computer Based Training (CBT) in which the student and/or learner can proceed through a course of logical instruction at his or her own pace, with repeat instruction where necessary and built-in monitoring of the progress made.

Of particular importance is the very large installed base (ie market penetration) that now exists and the fact that most schools and business executives have ready access to one or more PCs. In this situation it becomes comparatively simple to introduce some form of Computer Based Training. Continued development of the PC and in particular the introduction of expert system capabilities are expected to enhance even further its use in the education and training environment.

The Storage Peripherals

Also of importance are the advances made in storage device technology. Such devices are used for both the delivery of pre-prepared courseware and its storage and use by the educational system. Developments in storage peripherals have occurred in both data storage and video storage.

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In data storage, developments in magnetic recording media, and in recording head technology, have led to increases in areal storage density such that high performance systems operate now at 10,000 bits per mm and 100 tracks per mm (ie, 10^6 bits per mm^2). This thrust to higher performance has been accompanied by a parallel thrust to lower cost. These trends are expected to continue with a strong motivation coming from the parallel developments in optical storage technology. In general the laser accessed optical storage systems are able to provide an order of magnitude increase in track density and hence in areal density without a corresponding increase in system cost. Increasingly the optical storage devices are expected to be used for data storage purposes and of particular importance is the development of the CD-ROM (ie the read only memory system based on the Compact Disc).

Similar developments have also occurred in video storage. Reductions in costs and increases in performance have led to a large increase in the penetration and use of video cassette recorders (VCR). Increasingly the VCR with its ability to provide video as well as text, data and graphics has become an essential component of CBT systems and a necessary adjunct to the PC in education and training applications. Although the VCR provides a convenient low-cost means of distributing courseware it has the disadvantage that access is serial.

The development of video storage and distribution based upon the use of the optical video disc has had a major impact in education and training. In particular, the interactive video disc (IVR) has the multiple benefits of high efficiency low cost storage coupled with ease of replication and random (ie interactive) access. Already the Interactive Video Disc is extensively used in education and training systems requiring video and interactivity. Our research indicates that there will be a continuing development of the optical disc leading to increased performance and low cost.

In addition, of major importance to the educational and training environment is the development and introduction of optical disc systems having write once multiple read characteristics (the so called WORM disc) and the fully reversible read-write optical disc.

Also of importance are the developments associated with the Compact Disc (CD). Originally introduced for the storage and distribution of high quality audio, the CD is now being developed as a high capacity data storage device (the CD-ROM) and as an interactive device storing data and video (the CD-I). The convenience of the CD will result in it having a major impact in the educational and training sectors.

Display Technologies

To date, the visual display system used in the vast majority of PCs and IT-based training systems had been based on the CRT. Although adequate in terms of colour, speed and resolution the CRT is disadvantaged in terms of physical size, weight, and need for high voltage power supplies. Recent developments of flat panel display technologies based upon the use of plasma, liquid crystal, electroluminescence or vacuum fluorescence should result in the availability of high resolution flat-panel displays ideally suited to the education and training environment.

Communications

The Open University system for Distance Learning relies on a combination of broadcast material, published text and personal tutorials. New communication technologies now being developed and introduced open up the possibility of improved means of delivering course material and of providing the two way interactivity (ie student to tutor and vice-versa) that is required.

Cable networks that have been introduced for the distribution of TV programmes may also be used for the distribution of educational material. With the development and introduction of the Integrated Services Digital Netowrk (ISDN) the public network will have a means of transmitting and distributing courseware containing slow video as well as text, data and graphics.

In the longer term we can envisage the development and introduction of a pan-European optical fibre-based broadband network for the transmission of educational as well as entertainment and business services. Such a network is the aim of the European Commission's RACE programme (Research on Advanced Communications in Europe).

In parallel with these developments, we see increased use being made of satellites for the distribution of broadband television programmes and for the distribution of business information and educational services. In the US for example, where direct broadcasting by satellite (DBS) is well established, such techniques are already being used for the distribution of educational material.

In summary therefore, we have a technology scenario which leads to an educational or training workstation comprising an expert system-based PC, with flat panel display, and optical storage system which is linked into an educational/training network providing for the distribution of courseware and two-way interactivity as required.

But is there a demand for such a system? I believe there is.

THE MARKET PULL

Increasing evidence is being accumulated to support the view that IT-based learning can have a significant impact on the effetiveness and efficiency of the learning process. IBM, for example, has recently reported a significant improvement in training efficiency by the use of CBT.

State educational systems are under increasing pressure to improve the teaching efficiency and it is now recognised that computers and IT-based learning systems have a role to play.

More importantly, it is recognised by the business community that the effective application of IT has a significant impact on the future growth of businesses. The effective use of IT requires a skilled workforce trained in the use of IT and this implies a training programme in the use of IT. Computer-based training and IT-based learning systems provide the cost-effective means of supplying this training requirement.

In addition, in the high technology industries there is now an increasing awareness of the need to retrain the workforce four or five times during the working life of an employee. This presents the employer with a large training requirement which has been recently valued at $40 bn (source: Eurich - Corporate Classrooms) in the US.

Against this increasing training need there is the recognition of the large costs associated with conventional training methods and the need for corporations to improve their "bottom-line" profitability by the use of more cost-effective means of training the workforce. The use of IT-based learning provides the answer.

It is of interest to note that in addition to the normal workforce training that has to be provided, corporations also have specific training problems stemming from the rapid obsolescence of products and services and increasing levels of complexity in major information processing systems. Increasingly therefore, we see the application of IT-based training systems to the training of sales forces, of field support personnel and of users. The use of Interactive Video by the Rover Group illustrates this trend.

CURRENT INITIATIVES

The technological developments discussed earlier are proceeding in laboratories throughout the world without any specific reference to the needs of the education and training community. Several initiatives have, or are being taken in the context of IT-based training which are worthy of special note.

- In the US the National Technological Univeristy (NTU) has been established based upon the distribution of specialist training courses by satellite to a range of industrial corporations. Initiatives are now being taken by the PACE (Programme of Advanced Continuing Education) organisations to establish a comparable system in Europe.
- Within the European Community, a collaborative cost-shared programme, for the Development of European Learning through Technology Advance (DELTA) is being formulated and should become operational by mid-1988.

CONCLUSIONS

The actions discussed above will lead to the availability of IT-based products and services which can be applied, with benfit, to education and training. For this to happen there is a need for:

- a better understanding of user needs by the suppliers of the systems and services,
- a better understanding by users of the benefits that will accompany the application of IT to education and training.

Given the development of this understanding, we can anticipate an explosive growth in the use of IT-based education and training systems.

TI-IN NETWORK: A MODEL FOR WORLDWIDE SATELLITE-TRANSMITTED ACADEMIC RESOURCES

P. S. Tinsley*, B. H. Batson*

ABSTRACT

TI-IN Network, Inc., is the first private satellite network in the United States developed specifically to provide schools a cost-effective alternative for direct student instruction, professional and support staff training, and administrative support services.

The Network developed as a cooperative venture between private enterprise and public education. State agencies, institutions of higher education, professional associations, and nationally prominent educators offer the courses, award the credit, conduct the training, and host the meetings. TI-IN Network provides the end-to-end delivery system, the satellite transmission time, and the administrative coordination between program offerors and program participants.

The result of this unique approach to solving the problems facing public education in the United States is a state-of-the-art interactive-instructional satellite network which equalizes access to educational resources by removing geographical barriers to existing programs and courses for schools large andsmall, urban and rural.

OVERALL DESCRIPTION OF TI-IN NETWORK SYSTEM

The basic concept is a simple one -- provide a nationwide delivery system, administrative staff, and marketing structure for satellite transmitted academic resources and support services. TI-IN Network currently provides live, interactive-instructional television services to more than 300 subscribers in 27 states in the United States. These services include the following:

- High school credit courses.
- English as a Second Language instruction (grades 1-12).
- Inservice training and staff development programming.
- Basic skills tutorials.
- SAT and ACT test reviews.
- Student enrichment viewing.
- College credit courses.
- Community programming.

TI-IN's existing subscriber base includes high schools, elementary schools, school district administrative offices, regional education service centers, county offices of education, and state departments of education.

The TI-IN Network configuration provides four channels of high-quality television programming via the GTE Spacenet II geosynchronous Ku-band domestic satellite. Programs are currently originated and transmitted (uplinked) from the studio facilities of the Education Service Center, Region 20, in San Antonio, Texas. The satellite broadcasts these signals over the entire continental United States, where they are received by a large number of relatively inexpensive television receive-only earth stations located on subscriber premises.

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PROGRAMS AND SERVICES

TI-IN's basic product is its programming. All programs scheduled on TI-IN are done so directly in response to needs expressed by Network subscribers through a routine survey process. Program advisory committee meetings are also held via the Network once a month for subscribers to discuss questions and issues concerning programming -- schedules, presenters, announcements, evaluation, etc. As a result of subscriber needs and in response to concerns at the Department of Education level in various states, TI-IN is currently offering two new program areas which are highly innovative, and is in the process of developing a third such area.

Of the new programs already offered, the "Math Magnet School of the Air" represents a significant step forward in distance learning at the high school level, since it provides opportunities to those exceptional students who want to explore advanced mathematics. Courses offered under this program, which was partially funded by the United States Department of Education, have included linear algebra, probability and statistics, linear programming, and computer math II, none of which are normally available in the vast majority of high schools in the United States.

English as a Second Language (ESL), the second of the innovative program areas currently being offered, was developed to help fill the void created by the lack of certified teachers in this critical area. TI-IN offers an integrated program consisting of a combination of (a) direct student instruction, grades 1-12, (b) administrator and facilitator training, and (c) ESL staff development for regular classroom teachers.

Another new area which can prove to be of great value to TI-IN is the joint development (in conjunction with Education Service Center, Region 20, and the Texas Education Agency) of programming for Gifted/Talented students. The basic idea will be to help students develop higher-level thinking skills that will enable them to realize their full potential and gain maximum benefits from their learning processes.

Even though programming is the "product" of TI-IN, all equipment, installation, maintenance, administrative, and instructional support services required by a school district to use the Network effectively are provided. Three points of contact are all that are required for interface on any problem or question which might arise -- TI-IN offices in San Antonio, Texas, for all subscription, financial, scheduling, registration, quality control, contractual, and programming matters; a toll-free number for maintenance calls and for requesting video tapes of programs in case of equipment failure or local weather problems; and a toll-free number at the program originating offices (located at Education Service Center, Region 20) for instructional tutoring with high school teachers.

A subscriber to TI-IN Network receives immediate attention to equipment failures or technical problems (48-hour maximum response nationwide) so that students miss as little class time as possible. The video tape service insures that registrants can make up classes that are missed. With video taping capability in each receive classroom in a subscribing district as part of the Network design, classes can even be taped as they are received so that students who are absent during live instruction never have to miss a class.

TI-IN operates a full-service instructional network to insure consistent quality and service. Minimal training is required for any person in a subscribing district to learn how to use the equipment -- and that training is provided by the Network. The user-friendly technical design and full-service scope of TI-IN Network programs and services combine to make it the most viable alternative delivery system in the United States for public schools.

THE TECHNOLOGY

TI-IN operates the most technically advanced interactive instructional satellite broadcast system of its type in the world today. The state-of-the-art network features Ku-band direct broadcast satellite technology, which offers the advantage of high performance and low cost to the end user. Satellite transponder capacity is provided over the Spacenet II satellite under a contractual arrangement with a major satellite carrier (GTE Spacenet Corporation).

TI-IN offers a turnkey technical delivery system and assumes responsibility for the end-to-end performance of its programming. Video, audio, data, and talkback quality are all guaranteed. TI-IN provides and installs all necessary equipment to its subscribers. This equipment has several unique and innovative elements, some of which are proprietary to TI-IN.

The proprietary talkback design of the TI-IN Network features automatic dial response via toll-free phone lines. A student simply presses one button on a cordless telephone handset and is able to talk with the course instructor and be heard by classmates at receiving sites across the nations.

The TI-IN system also has a unique electronic copy (data distribution) capability for satellite transmission of exams, handouts, and assignments using low-cost dot matrix printers at the receiving sites.

Finally, a new technical innovation is the electronic writing pad, which offers a new dimension to instructional television. With its use, standard audio talkback phone circuits can convey hand-drawn information which can be of enormous benefit in many instructional situations. Equation solving, sentence diagramming, sketching of graphs and other pictorial information would be difficult (if not impossible) using only aural talkback. With electronic writing pads in the classrooms sending data over talkback lines for conversion into standard television signals that are re-broadcast out to each program participant, the instructional process can be greatly enhanced.

The next area of technical innovation which TI-IN intends to exploit is that of using personal computers (PC's) in the classroom along with headend-based PC's or mainframe computers to further enhance the instructional process. Use of computers for such areas as electronic tutoring; homework and exam administration, scoring, and feedback; and electronic mail will aid in the logistics/class management areas and should allow substantial increases in the class size limits to be realized. Even further advances should be possible as computer utilization is made more a part of the instructional process, such as by computerized drill and practice, computer simulations of laboratory experiments, etc. During 1988, TI-IN plans to fund a major research and development effort in those areas related to logistics/class management. Resulting developments will be utilized at least on a pilot basis in the fall semester of calendar year 1988.

SUMMARY

The benefits to be gained from a satellite-based resource sharing network, such as TI-IN Network, become obvious when viewed through the eyes of TI-IN Network subscribers. When asked why they subscribe to TI-IN, there were three categories of response that ranked consistently higher than all others.

The first was the capability of the Network to help schools implement legislated mandates.

The second perceived benefit of TI-IN Network was the fact that satellite distribution equalizes access to educational resources by removing the geographical barriers that have limited participation in critical subject areas by schools in the past.

Finally, schools and other educational agencies across the United States that subscribe to TI-IN Network are not only able to share resources but also the cost of those resources. This basic concept is not limited to the United States, nor or the problems addressed by TI-IN Network. Internationally, those countries, large or small, highly-developed or undeveloped, having access to satellite transponder capacity (either via their own domestic satellites or as members of INTELSAT) can look to TI-IN Network as a successful model for nationwide and worldwide sharing of satellite transmitted academic resources.

THE BROAD CONTEXT OF DISTANCE EDUCATION

Robert Gall*, Victor E. Fuchs°

ABSTRACT

Distance education is discussed in terms of its reliance upon (a) technology for its feasibility, and (b) societal, educational, and interpersonal communication factors for its success. Cybernetic influences, man's ability to use, control and benefit from technology, impact those who wish to develop and establish distance education services and bring a particular influence on those recipients who are located in remote and isolated cultures/societies. Care must be exercised to consider the societal implications of technology and cultural intrusion, as well as content relevance, implementation requirements, administrative constraints and alternative communication vehicles necessary to support the structural aspect of the information/distance education delivery system. A preliminary criteria is provided for each of these considerations supplemented by oral examples of distance learning projects carried out in the Pacific, mainland USA and northern Canada.

INTRODUCTION

This presentation is directed toward those charged with designing and implementing distance learning systems. While examples are designed primarily for special education environments to reflect the specific expertise of the authors, the generic applications are obvious. These notes are intended to supplement the oral presentation made by the co-presenters at the session. As such, it serves as an "advanced organizer" and a notational summary only. Illustrations of the basic principles raised at the session will be added orally, if time permits, using scenarios gathered from the Pacific area, the mainland USA and northern Canada. We outline several important issues associated with the introduction of distance education technologies. Some were originally discussed in the preparation of a Telecommunications Guide for remote regions of the Pacific, published by the Western Regional Resource Center based in Oregon, USA (WRRC, 1987). Others are presented here for the first time.

SESSION PRESENTATION

DEFINITIONS

In this presentation the following definitions will be implicit:

> "Distance learning" will refer to the provision of learning opportunities to a geographically dispersed multidimensional target audience. As such, distance learning activities will potentially affect formal, informal, and nonformal educational structures.
>
> "Formal" education structures are characterized by designated teachers who directly transmit information to students utilizing approved or sanctioned curricula, in a system that has at least a surface appearance of unity and purpose.

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"Informal" education is regarded as a concept that involves "a life-long process by which every person acquires and accumulates knowledge, skills, attitudes and insights from daily experiences and exposure to the environment," (Coombs, 1985).

"Nonformal" education structures refer to "any organized, systematic, educational activity carried on outside the framework of the formal system, to provide selected types of learning to particular subgroups in the population, (Coombs, 1985).

"Special education" will refer to the modification of educational content and processes to better serve students with needs that are unique relative to the majority's educational standards.

"Technologies" in this case will be used in a very restrictive sense to refer to computer-based and telecommunication information systems that, in our opinion, have great potential to assist the learning process.

BACKGROUND

We will discuss distance education as it affects two types of primary audiences: the remote (isolated) and culturally divergent and the distance separated and culturally homogeneous. The implications regarding the familiarity, understanding, and acceptability of the technology and information components required to implement distance learning systems are significant between these audiences requiring accommodation and flexibility in the planning process. The financial, technical, and professional resources of remote and isolated rural areas requiring educational services usually are more limited than those of metropolitan areas. Conversely, educational costs are usually higher because of distances to be spanned and reduced student enrollment in any single location. The effectiveness of educational undertaking in remote settings requires inordinate amounts of human energy and financial support. The stakes are high in terms of human costs and consequences. The resources required for homogeneous audiences separated by distance, yet with convenient access to technology structures or services, provide more opportunity for the reduction of costs and human effort on the part of the agency providing the distance education services. Regardless of which one of these audiences is being served, distance educational systems need to be very carefully planned.

Two sets of "challenges" affect planning for distance education services: technical and social. Many contemporary technological applications often strike the recipient as highly confusing. Arrays of communication technologies and isolated applications abound. Technical standards and equipment compatibility issues challenge planners in the design of the technical aspects of the system required to support distance education services and also jeopardize affordability. All technical requirements are implanted into extraordinarily complex social and physical environments. Therefore, careful assessment of environmental and human factors, as well as detailed evaluation of technological possibilities and applications, must be made. This presentation is designed to assist that process and relate those criteria that have been determined to be important based on the authors' experience.

RELEVANT CRITERIA

We will offer a series of guiding criteria to assist distance educators to determine the most efficacious combination of human and technological interfaces for their specific application.

Criterion No. 1: The Requirement for Forethought

Consideration of technological consequences is of prime importance for either audience: remote or distance separated. For remote audiences, distance education in all of its forms poses the possibility of greater cultural homogeneity (by the predominant culture) at the expense of the remote culture wherever it is employed. While distance education can be used to integrate new knowledge and information that can potentially enrich the recipient's educational opportunity, succcessful implementation requires careful consideration of many cultural and/or societal factors for either remote or distance separated audiences. How do social and cultural relationships change as a result of educational technology being injected into the prevailing educational structure? What social and cultural impact will they have? How might the basic institutions of a society, especially the family and the educational systems, be altered by technological implant? How do these basic institutions of society interact and control the technology? How might the society's culture, norms and values, and standards of behavior change as a result of external cultural infusion, which all information transfer potentially carries? Any technological tool provides a means to control the environment to some extent, with physical and social consequences that are both positive and negative. Accordingly, they arouse reactions ranging from abject fear to outright acceptance.

Criterion No. 2: The Need to Identify Student Characteristics

Administrators must be sensitive to the numerous cultural aspects that can affect distance delivery effectiveness for students or service users. To illustrate, if multiple languages are spoken, then a designed system may have to provide for multilingual transmission or set up different transmission times. Network configurations may be affected by both cultural variations and language differences. Socio-economic characteristics will affect the quality and quantity of home telecommunications equipment and specific educational needs. Predominant art forms and leisure time activity may indicate the most common ways people perceive and compose information and the communication styles most meaningful to them. Cultural values and traditions can indicate those powerful leaders who must be consulted before systems are designed (e.g., village elders) or the societal norms (e.g., priorities, customs) that must be accommodated and may also flag the most likely end users of the innovation. Ultimately, student characteristics, as social variables, address the acceptability of various types of distance learning systems to the community.

Selected criteria for student characteristics follow:

2.1 Languages

Inquiry: Penetration of a primary language? Languages used as: the official language? in school? in media? multiple languages?

2.2 Cultural Variations

Inquiry: Religion? Ethnic groups? Racial groups? Other divisions?

2.3 Socio-economic Factors

Inquiry: Literacy rate? Per capita income? Major occupations?

2.4 Predominant Art Forms

Inquiry: Music? Dance? Theatrical activities? Visual arts? Crafts?

2.5 Cultural Values and Social Traditions

Inquiry: Sex roles? Age roles? Learning traditions? Power hierarchy? Political systems? Family customs? Economic factors?

2.6 Leisure Time Activities

Inquiry: Sports? Interpersonal contacts? High culture activities? Mass media activities?

2.7 Social Concerns Related to Communication Systems

Inquiry: Opposition to intrusion via externally oriented popular culture? Opposition to intrusion by corporations, other nations? Moral concern about changing values, society? Opposition to technological change?

NOTE: Cultural information can be acquired from multiple sources for distance separated populations within a homogeneous society (e.g., existing databases containing census information, surveys and interviews with potential users of the system, government records, etc.). Gathering cultural data for remote and isolated populations and cultures, however, is not straightforward, particularly data related to values and traditions. Direct observation of the local environment is necessary to verify the reliability of the information gathered from individual testimony. Most importantly, in either case, in order not to impose external judgment upon those the system will serve, potential users should be asked to participate in both the data gathering and decision making processes. Local participation is especially important when considering Criterion No. 3, Prioritizing Key Tasks to Be Performed.

Criterion No. 3: Prioritizing Key Tasks to Be Performed

3.1 Identify Educational, Instructional, Informational and Professional Needs of Students

Inquiry: Connecting to the external world, resources, and peers in other locations? Retaining or acquiring, on the part of the student, a feeling of efficacy in solving problems through access to outside resources?

3.2 Program Implementation and Evaluation

Inquiry: How is an appropriate student constituency to be built? How is collaborative research and curriculum development encouraged? How is the ongoing status of the students recognized? Degree of instructor-student interactivity? Mentoring?

3.3 Other Communication Tasks Required for Student Support

Inquiry: Increasing connections to people in the outside world who speak the same language(s), share common interests, or are members of the same culture/subcultures? Increasing reception of cultural alternatives? Increasing opportunities for production and distribution of students' creative work?

NOTE: In reviewing key tasks, consideration should be given to how many tasks can be performed more effectively and economically locally or by training and establishing local contact persons to act as local system operators.

Criterion No. 4: Infrastructure Considerations

The following assists educators to survey existing resources and weigh related factors before selecting a communication infrastructure.

4.1 Related Postal Conditions

Inquiry: Is the postal service adequate? Does it provide reduced/special educational rates? What is the status of other transportation services for people and/or freight: by land? air? water?

4.2 Reproduction Equipment

Inquiry: Availability of photocopy? spirit master? mimeograph? Copy services available: public sector? private sector?

4.3 Common Carrier Conditions in a Region: Reliability and Availability

Inquiry: Electricity? Point-to-point common carrier communication? Terrestrial telephone (microwave, cable, fiber optic voice channels)? Satellite telephone? HF (single sideband) radio connections? Visual transmission capabilities: facsimile machines? low scan equipment?

4.4 Computer Access

Inquiry: Can the common carrier services be used for data transmission: micro-to-micro? mainframe-to-mainframe? micro-to-mainframe? mainframe-to-micro? Penetration of the region's computer facilities: residential? institutional?

4.5 Available Television Broadcasting/Cable Facilities

Inquiry: Availability to educators? Scheduling? Costs?

4.6 Direct Satellite Pickup

Inquiry: Availability? Penetration of: consumer satellite dishes? institutional satellite receive-only (downlink) dishes? institutional transmitting satellite dishes (uplink)? Local TV satellite news transponding equipment?

4.7 Broadcast Radio

Inquiry: Penetration of radio receivers: AM commercial? FM commercial? AM public? FM public?

4.8 Broadcast Television

Inquiry: Penetration of television transmission facilities: VHF commercial? UHF commercial? VHF public? UHF public? Penetration of commercial and public low power translators? Instructional television fixed service?

4.9 Electronic Storage Devices

Inquiry: Availability and penetration of electronic computer storage devices: fixed disc? flexible diskettes? bubble memory? mainframe? micro? Format: MS-DOS, other? CD-ROM? Availability and penetration of video storage devices: video cassette recorders? VHS/Beta format? 3/4", 1/2", and 1/4" format?

4.10 Miscellaneous Traditional Instructional Equipment

Inquiry: Slide projectors? Overhead projectors? Film projectors? Audiotape players? Card readers? Microfiche readers?

4.11 Local Environmental Factors

Inquiry: Effect on infrastructure choice and operation? Geographic factors? Climatic factors (note extreme of humidity, wind, temperature, storm/severe weather activity)?

Criterion No. 5: Administrative Constraints

5.1 Funding Source and Regulatory Constraints

Inquiry: Own government? Other government? Corporation? Foundation? Private voluntary organization? Development bank? Religious group? United Nations agency? Noncommercial multinational organization?

5.2 Government/Private Sector Policy/Legal Constraints on Content Choice

Inquiry: Patents? Copyright? Import regulations? Licensing? International agreements?

CONCLUDING PERSPECTIVE

The use of information technology such as microcomputers, telecommunications and communications satellites offers students in remote and distance separated communities unprecedented opportunities for major gains in both formal and nonformal education. However, many indigenous people throughout the world have historically experienced the negative consequences of cultural exploitation through imposed technology. When considering distance education programs, we must inquire as to the use of these new technologies in a socio-cultural context, as well as a logistical one. The challenge of providing effective distance education services remains an amalgam of technology, curriculum, cultural implications, student needs and expectations, and financial resources. Effective distance education systems are developing, but better models are needed to connect remote and distance separated students and professionals to outside resources for inservice training, information resources, diagnoses, supervision, instruction, administrative communication and other educational services.

DESKTOP PUBLISHING: A CURRICULUM FOR ADMINISTRATORS

R.F. Carey*

ABSTRACT

Desktop publishing programs are revolutionizing communication in the school and university setting. Teachers and administrators, always looking for ways to save time, have welcomed this innovation since it allows them to produce firsthand the flyers, reports, and charts that heretofore required the services of other professionals. The expediency and economy of desktop publishing initially obscure the need for a considerable array of design and editing skills.

Clearly, the design of training in computing should take into consideration the need for addressing graphics, layout, and editing. This training must go beyond the use of software features to include knowledge of the techniques and protocols of visual communication. An outline of a short course on desktop publishing is offered in this paper.

INTRODUCTION

When text appears to be typeset, it immediately assumes the mantle of respectability. Now advanced information handling technology can provide the trappings of professional typesetting at greater speed and less cost than traditional publishing. It should come as no surprise that this new technology--desktop publishing--is being embraced in both corporate and educational settings.

It is part of the nature of educational institutions to generate paper. The material can be directed towards instruction, or be part of administrative reporting and record keeping. In either case, effective use of these materials requires much more than just the appearance of high quality.

A commonly overheard statement in a photographic art gallery is "I could take a picture like that!" Of course, the statement is based on an ignorance of the necessary components that elevate a photograph from snapshot to art. The same phenomenon is beginning to appear in desktop publishing.

THE ILLUSION OF QUALITY

The elements of good publication design--the blend of art, psychology, and the practicality of good layout--are not obvious. Good writing requires good editing. Correct grammar, spelling, and structure come from knowledge and hard work. The effective use of graphics as a part of the communication process involves more than simply including a picture somewhere on the page. The growing number of desktop publishing systems will ensure more publishing. It will NOT ensure the quality of that work.

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There is also the matter of credibility. When materials bear the trappings of professional production, errors are all the more disturbing when they are encountered. Not long ago, I saw a full page glossy ad for some management oriented software that made me check the magazine cover to see if it was an April Fool's issue. In the space of five paragraphs of large type there were no less than fourteen spelling errors and three major attacks on conventional English grammar. It wasn't the April issue. Closer examination of the type revealed the small, but telltale, signs of laser printed copy. The company in question had obviously provided camera-ready ad copy to the magazine. While they undoubtedly saved money, they did so at the expense of credibility.

The principal reasons for the popularity of desktop publishing are speed and economy. A job that used to take several weeks, and cost several hundred dollars, can now be produced in-house in a few days, or even hours, with minimal expense. By eliminating the outside work, desktop publishing has reduced the overhead involved so much that virtually anything can easily be given the superficial appearance of a quality publication.

Unfortunately, the same steps of the publishing process that are bypassed by desktop publishing are those that traditionally served to ensure a degree of quality. Before desktop publishing, the journey from author to print usually included professionals in the field--editors, graphic artists, etc. This is no longer always the case. Uninformed or unsupported desktop publishing may well completely eliminate almost all quality control.

THE NEED FOR APPROPRIATE TRAINING

Like all skill bases, the factors that produce quality in-house publishing must be learned--and taught.

So what should training in desktop publishing address?

Equipment and software are perhaps the most obvious and, arguably, the least important components of such instruction. The vendors of desktop publishing software and turnkey systems are devoting a great deal of effort towards developing user interfaces that are both easy to learn and use. Knowledge of the keypresses and tools of desktop publishing should be a byproduct, not an end point, of a course.

Layout is one of those arts that is totally transparent when it is well done. It involves such diverse factors as artistic balance and the psychology of how humans see written communication. Again, software developers are providing as much help as they can. Standard layout templates are included with most systems. Documentation usually gives hints on how to put together an effective layout. Instruction in layout design can build on these guides to provide depth and encourage creativity.

Editing is a most elusive art and it seems unlikely that any single course of instruction can adequately substitute for the years of practice that are necessary to make a good editor. There is, however, a wealth of tricks and helpful hints that can guide the novice while experience is gained. Purely mechanical aid is available through electronic spelling checkers and a growing number of style checkers.

Instruction can provide some of the practice and feedback necessary to establish some degree of editing skill in would-be desktop publishers.

Tools don't make an artist. Yet graphic art is one of the more powerful facets of desktop publishing. The art work that turns up in most publications tends to fall into two categories: illustrative and informational. A common tool of the graphic artist is "clip art"--prepared illustrations that can be cut out and used as part of a paste-up. Software versions of this artist's aid are becoming quite common. A glance through any copy of Time magazine or USA Today will show examples of informational graphics--diagrams and charts that show processes or present statistics in a more readily understandable form. Again, software is available to turn mysterious columns of numbers in a spreadsheet into graphs. Here we are faced with a smaller version of the larger problem being discussed in this paper. Visual communication through graphics is a discipline worthy of study--not just a byproduct of application software.

A SHORT COURSE ON DESKTOP PUBLISHING

As equipment that is capable of supporting desktop publishing becomes available in schools, the need for properly prepared users becomes more acute. Fully half of the battle lies in making users aware of the details and subtleties involved. Skill will only come through practice.

It is my recommendation that potential users be exposed to a survey of desktop publishing topics. Such a course could be a curricular unit, a series of inservice workshops, or even self-study, supported by a tutor or consultant. Whatever the method chosen for information delivery, it is imperative that hands-on practice is an integral part of the instruction.

Below is a suggested sequence of topics for potential users of desktop publishing.

The Impact of Desktop Publishing
- the product
    - reports; newsletters; books; forms
- the process

Hardware
- graphics based microcomputer systems
- printing camera-ready copy
    - electronic typesetters; laser printers; dot matrix printers
- large screen displays
- digitizers

Software
- a survey of popular desktop publishing programs
- using general application programs for desktop publishing
- page description languages

Editing
- editing conventions and notation
- common style errors
- punctuation and hyphenation

Editing (continued)

- electronic writing aids
    - spelling checkers; style checkers; on-line thesaurus

Layout

- the basic concepts of layout
    - consistency; style; appropriateness; balance; experimentation
- format
    - columns; headlines; margins
- manipulating type
    - type size; type style; positioning type (leading, kerning, white space, and screens)
- graphics in a layout

Graphic Art

- object oriented graphics
- bitmapped graphics
- graphics programs
- clip art
- presentation graphics
- incorporating illustrative graphics into charts and graphs

Future Developments

- the drive for higher resolution
- faster, bigger, better

Selected Bibliography:

Donahue, B. The Language of Layout. Prentice-Hall: Englewood Cliffs. 1978.

Munce, H. Graphics Handbook: A Beginner's Guide to Design, Copy Fitting, and Printing Procedures. North Light Publishers: Cincinnati. 1982.

Parker, R.C. The Aldus Guide to Basic Design. Aldus Corporation: Seattle. 1987.

Pickens, J.E. The Copy-to-Press Handbook: Preparing Words and Art for Print. John Wiley & Sons: New York. 1985.

Skillen, M.E., Gay, R.M., & others. Words Into Type. Prentice-Hall: Englewood Cliffs. 1974.

MATHEMATICS TEACHING FOR THE NEXT MILLENIUM

R R Burnside, A R G Macdivitt, N Pitcher, E T West

ABSTRACT

It is remarkably easy to make use of computers in the teaching of mathematics. It is quite another matter, however, to be confident that this necessarily leads to an increased understanding of mathematical ideas on the part of the student. Atiyah (Ref 1) has commented, with eloquence and some force, on the possible intellectual dangers which can result from an uncritical use of computers in the classroom. In our experience, the course which students are following - especially first year students - must be designed so that the computer is an integral part of it and not merely an optional extra of value in relieving numerical drudgery. This requires a great deal of effort by teaching staff in re-appraising their teaching style from a fresh viewpoint. At Paisley, computers have been used for six years in the teaching of mathematics to degree students in the School of Science. The presentation illustrates the use of the Mathematics Laboratory, MATHLAB, our successes and failures, identifies problem areas and indicates our hopes for the future.

INTRODUCTION

In mathematics - as with other areas of intellectual activity - one has to distinguish the final, polished result from the actual intellectual process of achieving that result. It is relatively straightforward to design software for the former, eg. drill and practice routines, symbolic manipulation packages, black-box numerical suites. This is not to say that these are necessarily easy tasks nor that the mathematical community is completely satisfied with what is available, but at least we know what must be done and have strategies to achieve this. It is much more difficult to design software which couples student with machine in a worthwhile instance of genuine mathematical activity. Some measure of success has been achieved for students at particular stages in their education and working in suitable environments, eg. the use of LOGO in classes with time for pupils to experiment and where teachers have some freedom from curricular and assessment constraints. In higher education we have the promise of a technology that can be significant in the teaching of mathematics - as practitioners know it; not the spartan form used in many texts. Polya's writings (Ref 2) demonstrate the nature of mathematical thinking and we must strive to encapsulate this in our software, ideally by designing general purpose tools and creating an appropriate environment for their use. Our knowledge of relevant cognitive structures is tentative, however, and this objective remains a goal, not an actuality. As a first step much can be done within the context of specific scenarios even though these are admittedly narrow in design and scope.

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MATHLAB ENVIRONMENT

MATHLAB is housed in two dedicated laboratories each with machine area and work area and each able to accommodate 20 students. The laboratory is fully utilised by 3 classes

1st Year Mathematical Sciences (x 140 students: 2 hours/week)
1st Year Computing Science (x 70 students 1 hour/week)
2nd Year Mathematical Sciences (x students: 2 hours/week)

and is available on open access at any time during the day when not occupied by classes. Students are encouraged to use the facilities available and are given some courseworks to do which require use of the machines.

Students have access to several menus of programs most of which have been produced "in-house". A full-time software technician is attached to the laboratory, and new software is produced from a succession of screen layouts prepared by the lecturing staff, coded by the technician and polished after consultation between lecturer and technician. Some years ago the time required for this was measured in man-days but with experience and some routines which can be used in different situations the time required is now measured in man-hours.

PHILOSOPHY OF MATHLAB

As part of a student's Mathematical education, he should experience, as, realistically as possible, what we perceive to be "normal mathematical activity". The components of such activity could be listed as

being presented with a problem,
puzzling over possible methods of solution,
discussing the problem with colleagues,
seeking advice form a tutor,
using a machine to experiment, to compute values and check conjectures and to interrogate graphical displays.

In designing MATHLAB we have attempted to include a component which offers this experience.

The second component which we have included is of a tutorial nature. Some aspects of the course can be presented most vividly using the graphical capabilities of the micro and material has been produced to illustrate and reinforce work covered in the lecture course. Examples of each of these uses of the laboratory will be demonstrated.

LESSONS FROM THE PAST

From the start, we were aware of the dangers of producing highly polished demonstration type programs. Certainly, it is tempting, eg. in evaluating a definite integral to show the decreasing interval width, allow the machine to calculate successive approximations to the integral and feel well satisfied with the result. However unless the student has been actively involved somewhere along the line it probably makes little more impression than watching T.V. To ensure that the student is stimulated to think about the concepts before him it is essential that a worksheet is provided for each tutorial or laboratory session on the machines. It is probably true to say that more mistakes have been made with worksheets than with software and we have developed the following guidelines.

The specific concept to be studied or problem to be solved should be explicitly described in a form suitable for the particular group of students.

If appropriate, the work should involve some conceptual effort on the part of the student and some investigative use of the machine.

The labsheet should not be too ambitious.

It has been found helpful to use the touchstone:

"if you cannot write out clear objectives for the labsheet in one sentence then you are probably committing at least one error and possibly two".

In all cases, the student is required to write up a report on his work. As a rough guide, a two hour laboratory session would be used as follows:

About 10 minutes familiarisation with the software.
About 1½ hours in devising and performing experiments to explore the concept.
About 20 minutes writing up a report with clear conclusions.

The report is invaluable in requiring the student to organise his thoughts on the work of the session, and, to learn the technique of report writing.

As good quality software has become more easily produced and we have learned to fine-tune our labsheets to suit the students, we have become highly satisfied with the results. We feel that the students are involved more actively in the learning process, student motivation has increased, development of mathematical insight has increased, students are more able to communicate mathematical ideas and have learned to use staff as consultants rather than as slave drivers.

HOPES OF THE FUTURE

Six years ago it looked as though only certain topics in mathematics were appropriate for laboratory sessions. As staff have gained experience, more and more ideas for laboratory sessions arise and now we are in a position of having to be highly selective in deciding what to include and what must be omitted. It is now also clear that other groups of students within the College would benefit from a MATHLAB component in their course.

In some of our software, we are limited by the present hardware eg. in material involving recursion and graphics displays. The next update of equipment will greatly extend the range of what can be achieved.

One slight cloud on the horizon lies in the apparent view, despite pleas to the contrary, that mathematics is entirely conceptual and is not also an experimental discipline like, eg. engineering, computer science, chemistry, physics or even economics! Progress requires that that attitude be reformed and the sooner, the better: THE NEXT MILLENIUM DEMANDS IT.

REFERENCES

1. M F Atiyah — The influence of Computers and Informatics on Mathematics and its Teaching, ICMI Study Series, (Cambridge Univ. Press 1986)

2. G Polya — Mathematics and Plausible Reasoning, Vols I, II, (Princeton Univ. Press 1954).

CHALLENGES OF THE INFORMATION AGE

Ruth E. Randall

ABSTRACT

The use of technology in the information age for teaching and learning is limitless. Educators will have to work with policymakers, business, and the learners themselves in determining curriculum, instruction, and assessment. Gifted, special education, and second language students will benefit from technology as well as the average student.

CURRICULUM

"The transformation from an industrial society to an information society will be one of the most overwhelming forces for change people have ever experienced . . . . The major institutions of our society, including education and government, based as they are on industrial era premises, will undergo considerable change." (ref. 1)

Determining a curriculum to fit the age of ever-expanding information will be a key element in planning for the future. In a society where businesses are fast becoming computer-based, our students need to be familiar with the use of technology to access information. Instruction in the use of technology, the teaching of hands-on ability to sign onto a computer for the purpose of word processing, editing, doing calculations, creating graphics or music, must be an integral piece of the curriculum in this age.

Since the uses of technology range so widely, the curriculum will need to focus on the needs of different students. Teachers will need an open attitude toward the uses of technology, an attitude of enthusiasm about discovering computer applications. It is of utmost importance that schools provide a sense of safety and familiarity with computers, for students will most definitely need to consider technology "user-friendly" in order to survive and succeed in their lifetimes.

The role of the politician in designing a curriculum that includes technology cannot be underestimated. Minnesota is a leader in this area because some of its prime policymakers made it a priority. Funds were allocated for the purpose of preparing a curriculum that expanded the uses of technology. Such advances require allotments of time and money; therefore, the awareness and support of policymakers is crucial. Business people are also a strong asset to any task force designing curriculum. Those in business know what students need for they know how learning is being applied in the work world. Input from the business sector can provide practical insights in the area of general and vocational education.

The role of administrators in designing this curriculum is also vital. Due to their role in making financial and curriculum decisions, administrators should be familiar with hardware and software needs and costs. Ideally, they should be able to advise those working for them. Teachers are in the best position to discover ways for applications to enhance the body of knowledge they are teaching. Last but not least, students' interests must be a guiding force in designing a curriculum that is relevant.

It seems imperative that there be persons assigned to learn technological applications. Software is a changing commodity, one that needs to be researched continually. Quality courseware and software exist. The personnel to find it and know its uses will need to be trained. As long as the opportunity is provided, most students will be able to have a value-added curriculum; in the process of learning to write an essay on a computer they will also learn word processing; in the process of researching a history question they will learn how to use a data base.

INSTRUCTION

Due to the limitations of cost, it is not realistic to assume that every student could be provided with his/her own computer, either at home or at school. Public schools in Minnesota are set up with a computer lab which allows for individual as well as classroom use. Using a sign-up or walk-in basis, this allows every student access to a computer. This system requires teacher initiative to expose his/her students to computer use and to encourage it. It would be easy for some students to slip through the cracks, however, and that is why an across-the-board commitment to the use of technology, especially among teachers, will be important in order to effectively train students.

In Minnesota we have discovered that computer-assisted learning works best. The teacher is still the primary force in the classroom and guides how and to what extent technology will enhance his/her teaching materials. "Computer technology in the classroom . . . is coming to resemble an electronic teacher less than a great book sitting on a well-built shelf - it can do no good if there is no teacher to steer students toward it, teach them to read it and inspire them to learn from what it says." (ref. 2) A computer-based education relies on the computer as the primary teaching instrument. In some cases, this system seems to work for hard-core dropouts and literacy programs.

Studies show that all segments of the population can benefit from the use of computers; the gifted and talented, the average, the handicapped. Gil Valdez, manager of the instructional-design section of the Minnesota Department of Education, states that a recent computer project in the public schools "gave the gifted access to data and ways of analyzing not available in books - they created new information." (ref. 3) Computers provide a way for creative and curious students to expand their horizons.

At a recent international conference on technology and curriculum held in Minnesota, there were several workshops focusing on the use of technology with the handicapped. The synopsis for two such workshops ran as follows: 1. "Presenter will discuss a program for severely emotionally/behaviorally disordered which uses computers in instruction and reinforcement. Computers are used as a key component in instruction, as reinforcement for targeted behaviors and as an activity involving groups of students." (ref. 4) 2. "A presentation and demonstration of peripheral devices to enable mentally retarded and multiply handicapped students to use a computer. Presenters will demonstrate authored software and appropriate commercial software to meet the individual needs of students." (ref. 5) Both of the above programs as well as others like them have been successful in using computers with the handicapped in a variety of ways.

In an age where children have been raised more than ever with TVs, videos, and the media, the potential for telecommunications as a learning device is great. Its application is most apparent for distance learning and low incidence courses. The use of a fiber-optic link to provide lectures via interactive television has been in use in rural Minnesota, as well as across the country, for some time now. One teacher can originate classes to be used in several schools, a solution to too few teachers in some courses and too few students in others. Yet the use of telecommunications beyond distance learning and low incidence courses has not been fully explored. Would it be more cost-effective? Would it enhance certain kinds of curriculum? These are questions yet to be answered.

ASSESSMENT

Assessment is an important concept in education technology and must be carefully devised from the outset. There is potential for student achievement to be greater as well as more applicable to their future needs. In order to assess, however, whether computers and telecommunications have been responsible for learning, specific objectives must be selected. Those who have been instrumental in designing objectives should play a major role in evaluation, as should staff, students, and community members. Assessment is most successful if a variety of approaches, such as surveys, questionnaires, observation, interviews, tests, case studies, are used. As we discovered in Minnesota, "a key step in the total plan (of educational technology) is the periodic measurement of progress on the goals that have been established. This phase will flow naturally if the objectives are stated in terms that can be easily monitored." (ref. 6)

While all students can benefit from the use of computers, it is true that those with computers at home will have an advantage. It is up to schools to offset this advantage by providing exposure to computers for all students starting at a young age. "Equal access is extremely important if technology is going to play an increasing role in the marketplace." (ref. 7) Computers have been shown to raise the achievement level of at-risk students as well as students from low socioeconomic backgrounds, if they are provided with a means to do so. Some English second language students have been known to feel more comfortable working on a computer than speaking the English language. Computers can assist them in learning the language.

The potential use of computers is limitless!

REFERENCES

1. Minnesota State Department of Education, Planning for Educational Technology (1983) p. 10.
2. S. Hencir, Computer User (1987) p. 34.
3. Ibid., p. 35.
4. Technology Supports Curriculum: A Minnesota Showcase, An International Conference Manual (1986) p. 21.
5. Ibid., p. 23.
6. Minnesota State Department of Education, Planning for Educational Technology (1983), p. 55.
7. Ibid., p. 56.

THE IMPACT OF NEW TECHNOLOGIES ON HUMAN RESOURCE DEVELOPMENT IN HIGHER EDUCATION

David Owens*

ABSTRACT

The emergence of new technologies has led to the installation of new academic programmes designed to help students acquire a range of competencies related to information technology. Even traditional courses are being modified to take account of the storing and sorting power of computers. It is hardly surprising, therefore, to find that new technologies have the potential to affect both the content of human resource development programmes and the way in which these programmes are delivered to faculty and staff.

The aims of human resource development may be accomplished in a great variety of ways, all of which may be affected in some way by technological innovation. Those responsible for promoting human resource development should try to harness the capabilities of new technologies to ensure that human resource development programmes meet the continually changing needs of personnel in higher education and do so in ways which are cost effective.

INTRODUCTION

Evidence of the introduction of new technologies surround us wherever we are. In homes, for example, we find microwave ovens, digital compact disc players, micro-computers, and electronic games. In industry and commerce we find computerised accounting systems, electronic tellers, computer-aided design, desktop publishing, teleconferencing, machine translation, and electronic mail. These technologies, which have such a widespread impact on society in general, have also affected and will continue to affect our universities and colleges.

Without attempting to be comprehensive, we can see that the new technologies have affected the curriculum, institutional administration and, to a lesser extent, teaching methodologies. We have seen the installation of new academic programmes designed to help students acquire a range of competencies related to innovations in information technology. New academic programmes include computer studies, information technology, digital electronics, and educational technology. Even long established courses, such as languages and history, are being modified to take account of the storing and processing power of computers. Financial administration is now often largely computer based, as is the administration of student admissions, examinations, and library services. With such a widespread adoption of new technologies in our universities and colleges, it is hardly surprising to find that these same technologies have the potential to affect both the content of human resource development programmes and

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the methodologies of delivering these programmes to faculty and staff in our universities and colleges.

HUMAN RESOURCE DEVELOPMENT

Human resource development in higher education, known in some countries as staff development, has in the past often been thought of as a few short courses for academics. In contrast, a more comprehensive view takes into account the disparate development needs of all categories of personnel in higher education. Its purpose is to develop the teaching, research, management, administrative, technical and secretarial capacities of members of universities and colleges so that they will be enabled to carry out more effectively the tasks and responsibilities which face them in the future.

Because of its disparate aims and variety of clients, human resource development can be effectively achieved only by implementing a variety of strategies. Institutions which are deeply committed to fostering this type of personal development sponsor activities such as:

- the acquisition of further degrees;
- sabbatical and other forms of leave-of-absence;
- participation in short courses;
- attendance at conferences;
- the provision of specialist advice to personnel; and
- the creation, installation and monitoring of human resource development policies.

The implementation of each of these strategies can be assisted by technological innovations. Those responsible for promoting human resource development in higher education should be willing to harness the capabilities of new technologies, such as audio and teleconferencing, interactive video, computer-aided learning, data-base management, and electronic mail, so that the content of human resource development programmes meets the continually changing needs of personnel in higher education and does so with the aid of technologies which are cost effective.

THE CHANGING CONTENT OF HUMAN RESOURCE DEVELOPMENT

New technologies are affecting what people do in our universities and colleges and how they do it. The range of skills required by teaching and non-teaching staff is expanding. Clearly staff need to keep up-to-date in their own area of specialisation, a task which is increasingly more difficult as the half-life of knowledge shortens. Staff also need to develop a range of new skills in areas such as:

- handling software packages. In most areas of university life software packages are important aids to our activities. These include word processing packages, electronic mail, desk-top publishing, statistical packages, computer management systems for the administration of admissions, examinations, and budgets;

- managing innovation. For example, the introduction of word processing systems into secretarial areas involves diplomacy, leadership and negotiation skills;

- producing audio-visual materials. Graphics software and desk-top publishing now makes it economically feasible for educators to produce their own audio-visual materials and to publish monographs and books. Authoring systems simplify the process of generating computer-based courseware.

o analog digital interfacing, which makes possible the linking of analog devices, such as those used in scientific experiments, to digital equipment, usually computers, to conduct and monitor continuous experiments.

These are just a few examples of the many areas which the new technologies affect the content of staff development programmes and it is important that those responsible for staff development provide the opportunities for faculty and staff to develop knowledge and expertise in each of these and other areas.

METHODOLOGIES OF IMPLEMENTING STAFF DEVELOPMENT

Collaboration among Individuals and Institutions

New technologies such as electronic networks and audio/teleconferencing will encourage enhanced collaboration among individuals in different academic institutions, nationally and internationally. At present, most universities and colleges conduct their own human resource development activities more or less in isolation from other institutions. New technologies will provide a means for institutions to access staff development expertise in other institutions quickly and economically. A central database containing information about staff development activities and expertise in each institution could be made available to other institutions via a computer network.

Delivery of Short Courses

Computer-based courseware could be used to help individuals develop skills in a number of areas. Computer-aided learning programmes could be produced on topics such as "Teaching and Learning at University Level", "Developing a New Course", "Writing for Publication", and "Stress Management". These could then be studied on personal computers, thus counteracting the reluctance of many staff to attend short courses.

Acquisition of Further Degrees

The number of teaching and non-teaching staff wishing to acquire further academic qualifications is increasing. Staff embarking on a PhD often find it difficult to locate a suitable research supervisor. Areas of research are often highly specialised and the supervisor must be familiar with the proposed research area. International computer networks could help by making available a listing of potential research supervisors. They could also assist by enabling the electronic delivery of draft theses, and by providing a means for conducting on-line discussions between student and supervisor.

Leave-of-Absence

Academic staff who have been teaching and researching for several years can benefit considerably from a period spent in another institution, usually another university. A computer-based clearing house, an international database holding information on those wishing to take sabbatical leave and other forms of leave-of-absence would facilitate those wishing to take a leave of absence. This database could list the curriculum vitae of each person and their preferred location, duration, and date of sabbatical. This would be of particular interest to institutions and departments which wish to host personnel on sabbatical leave.

The Provision of Specialised Short Courses

The provision of a series of courses relating precisely to the needs of academic and other staff members in higher education is a conventional staff development function. An institution may gain a national reputation for particular courses and attract people from other institutions. A database of all short courses would facilitate the marketing of courses. Reservations could be done on-line thus providing up-to-date information and reducing administration expenses. In addition, course designs and course outlines could be made available to those designing courses in other universities.

Some courses could be developed as courseware using floppy-discs and/or interactive video. Some could be delivered on-line.

Individual Advisory and Information Service

Even though a confidential advisory/counselling service which helps staff to plan their careers and select development opportunities depends primarily on the interpersonal relationship between the advisor and the employee, technology can play an important role Considerable information is required to make valid decisions. Much of this is currently available in the form of printed brochures, detailed regulations, course outlines, price structures, entry standards, and so on. Much of this information could be stored in a database and accessed directly by the employee.

Policy Development

In developing policy in relation to Staff Development it would, once again, be useful to have available on-line the sort of 'grey literature' which is available internally in most universities. It is not often published but after some time it is usually not regarded as confidential.

Conference Attendance

The reading of papers at international conferences is an important way of developing important skills among academic staff. Currently information on the nature, content, location of conferences is provided primarily by mail. It might be provided more efficiently using international electronic mail. This exists currently in such systems as EARN/BITNET.

TRANSFERRING KNOWLEDGE IN AN OBJECT ORIENTED CONTEXT

Pierre MARCENAC, Danièle HERIN-AIME *

ABSTRACT

Actual ICAI models are mainly based on a teacher-provided knowledge, and structured with the objective of teaching [MARC 87]. Here we hold the hypothesis of a knowledge described by a domain-specific expert and used for different applications. This expertise is assumed to be described in terms of objects, from a meta-knowledge independent of the domain expert and integrating static and dynamic behaviours.

This paper presents how this knowledge is represented and the concepts which must be connected with it, with the aim of correctly transferring it to a learner.

Then we emphasize the impact of adding these concepts for taking into account required learner's knowledge, tutorial strategies driven by an history of the teaching process, and problem generation.

INTRODUCTION

The "real" knowledge "deliberately" assumes the use of information we have ; so, the problem is to find adequate structures for transferring this expertise knowledge to different learners. Our model is inspired by existing ones integrating an expertise knowledge, a learner model and a tutor module [FEIG 80].

In this paper, we present, in a first time, the knowledge representation method which is used in our model. Then, we describe necessary concepts to be added to the expertise knowledge and the learner model that aims at integrating functionalities needed to obtain a good knowledge transfer to a learner.

Finally, we emphasize the impact of adding these concepts for the general behaviour of the system.

KNOWLEDGE REPRESENTATION IN THE MODEL

OBJECTS TYPES

The knowledge base is described with a model defined on a set of model concepts. These model concepts are highly interrelated, so our aim has been to decompose the model concepts in very detailed types intended to describe most of the relationships between them all.

A concept of model is a data abstraction that can physically be represented by a software descriptor called "object". The application concepts, which describe the studied problem correspond to object instances. The representation of collections of model concepts and relationships is done using networks, called "object-schemes", in which one node represents one object and one arc identifies one relationship between objects. We distinguish 5 object types :

Object of type 1 : an object correspond to a model concept (generic object).
Object of type 2 : an object correspond to a model concept category (specialized object).
Object of type 3 : an object describes an integrity constraint between concepts or concepts categories of the model.

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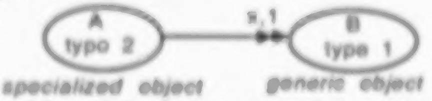
Object of type 4 : this object describes a property of a model concept, of a category or of a constraint.
Object of type 5 : an object describes a state, an event of another object type. It corresponds to a dynamic knowledge and permits to describe the model working.

RELATIONSHIPS TYPES

The first two types of structural abstraction for relating objects have been borrowed from semantic networks.

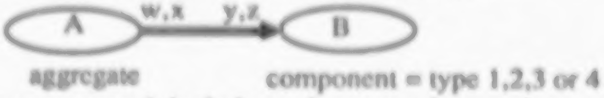
Relationship of the first type : a generalization (/ specialization) relationship, called "is-a", link a generic object with specialized objects. The specialized object is only defined by its distinguishing properties.



with $x \in \{0,1\}$

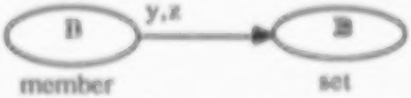
An instance of the object A is an instance of the object B. An instance of B may be an instance of A. A generalization relationship does exist between one object of the first type and corresponding objects of the second type.

Relationship of the 2nd type : the aggregation relationship, called "is a part of", is applied to compose an object with its properties, and to form aggregates.



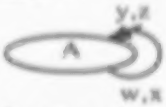
One instance of the aggregate A includes at least w values and at most x values of the component B. One value of B takes part at least in y instances and at most in z instances of A.

Relationship of the 3rd type : The association relationship called or "is member of" :



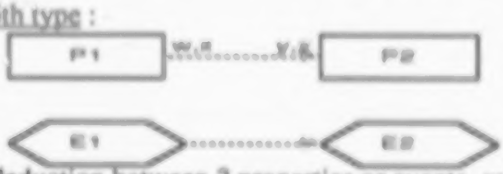
The association relationship of the semantic network means that B is a member of the 𝔅 set. One instance of B belongs at least y and at most z sets 𝔅.

Relationship of the 4th type : the cyclic relationship connects an object to itself.



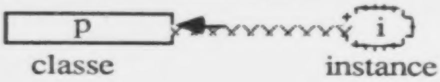
It is a particular case of aggregation, association and generalization.

Relationship of the 5th type :

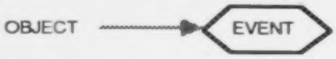


The relationship of deduction between 2 properties or events, called "deducts", signify :
- **first case** : the first property values take part in the deduction of the 2nd property values. One value of p1 takes part in the deduction of at least w values and at most x values of p2. One value of p2 is deducted from at least y values and at most z values of p1.
- **Second case** : The event E1 is the cause of the event E2.

Relationship of the 6th type : this relationship represents the classification, i.e. the relationship which links one class and its instances.


p
i
classe
instance

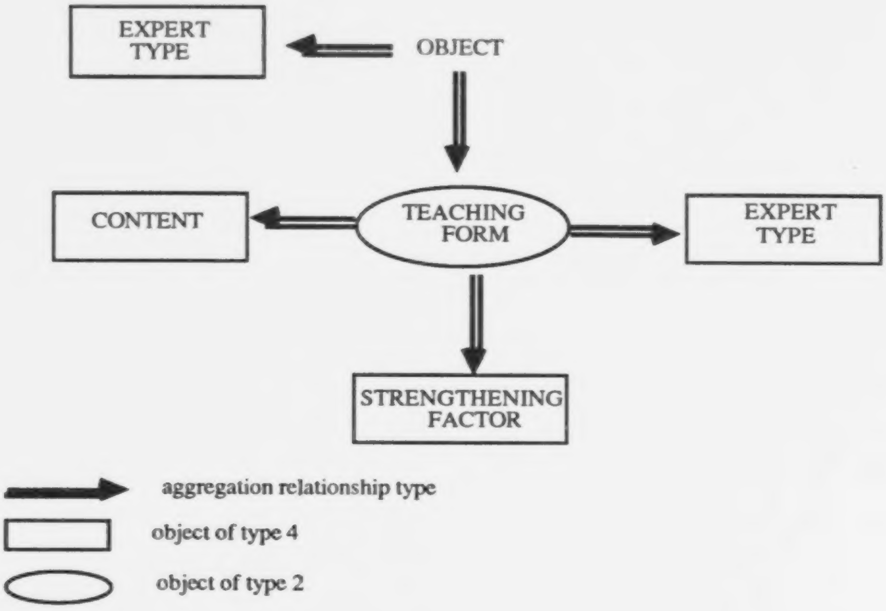
Relationship of the 7th type : this relationship, called "is in (at) the state of", is always coming on an object of type 5. It starts from objects of all types except type 5 and its cardinality is always 1,1 :


OBJECT
EVENT

TEACHING FACETS

CONCEPTS TO BE LINKED UP WITH KNOWLEDGE

We discuss, here, about objects to be connected with the living ones by aggregation relationships in the expertise knowledge with the aim of learning it.
Instances of these new objects are given by experts during the knowledge acquisition :


EXPERT TYPE
OBJECT
CONTENT
TEACHING FORM
EXPERT TYPE
STRENGTHENING FACTOR
aggregation relationship type
object of type 4
object of type 2

EXPERT TYPE :
It permits to know whose is aimed this object (whose learners ?). This notion is the knowledge level to be acquired by a learner to hit his goals.

TEACHING FORMS, EXPERT TYPES, STRENGTHENING FACTOR AND CONTENT :

The teaching forms are connected with all objects of the expertise base. They are given with the expertise knowledge ordering to the different teaching forms we dispose on it (picture, sound, text...). We can also indicate the expert type who disposes of this form. Indeed, the choice directly depends on the considered object and on the expert who has given this information. So, it is balanced by a strengthening factor measuring successes or failures of the situation transfer to the different learners. This one enriches progressively the expertise knowledge with experience, and allows the system with defining the ideal

teaching form of objects.
The content describes the action (picture, text, sound...). It is adapted to :
- the actual step (object on which we are working),
- the teaching form and its success measure.

CONCEPTS OF THE LEARNER MODEL

If the system has tutorial strategies, these ones will be better used if learners are known by it. So, the system must dispose of information about students which indicate as faithfully as possible :
- his knowledge level about teaching-domain,
- his learning processes independently of domain (evaluation on learner),
- his goals.

KNOWLEDGE LEVEL

The knowledge level of the learner can be seen as a picture of the expertise knowledge base ("OVERLAY" model) [CARR 77]. It only contains the objects linked up with the affected expert (a learner is an expert-apprentice) and specially :
- the set of known concepts by the learner,
- the set of paths which are borrowed and known by him in the network,
- some concepts linked up with knowledge about teaching account (teaching form used and its success during time).

EVALUATION ON LEARNER AND HIS GOALS

This is general knowledge about the learner independent of teaching domain and it principally relates to :
- the teaching forms he recommends whatever the expertise domain, balanced by a strengthening factor measuring the best achieved results,
- the intervention types which have better worked on him (for example repeat the question, find an example...),
- his goals.

These considerations will allow the tutor to choice a tutorial strategie which will be the most adapted to both situation and learner.

IMPACTS ON THE GENERAL MODEL WORKING

We discuss here about consequences of the previously described teaching facets add on the general system behaviour and mainly on :
- tutorial strategies and intervention methods evolution,
- learner model management.

TUTORIAL STRATEGIES EVOLUTION :

Tutorial strategies are formulated into rules allowing a teaching dynamic representation. The rules nature is expressed by several types :
- Rules directly linked up with the learner model (knowledge level, evaluation on learner) and independent of expertise.
- Rules linked up with domain-specific knowledge.

The rules semantic puts it by :
- intervention types (repeat, correct, explain, approve, ask, find examples...),
- intervention modalities (how and why choose one of the intervention type).

The different modalities always depend on the learner's comportment analysis and based on :
- acquired knowledge of the learner (known objects, borrowed paths, learner account),
- his goals,

- the problem solving step.

So, teaching facets linked up with the learner model, specially dealing with the history of the teaching process permit to appreciably improve the comportment of intelligent tutoring systems, taking into account tutorial strategies which are more numerous and varied.

PROBLEM GENERATION

The problem generation is selected by the tutor after a student wish, after the measure of his misconceptions (given by the borrowed paths factor) or an intervention type of a particular rule ("give an example", "give a similar problem", ...).
To work suitably, the problem generator needs some parameters like :

- objects types,
- relationships types,
- objects and relations,

on which the tutor wants the learner to work on.

The problem generator chooses a particular object to make the problem according to the tutorial aim drawn by the tutor and the different steps to hit by the learner according to expert type seen in the network during problem resolution.
Here again, the presence of teaching facets allows the system to be performant in both problems and tutoring proposed to learners.

CONCLUSION

The aim of this paper is triple :

- to show the interest of adding concepts to an expertise for specific applications like teaching one, in an object oriented context,
- to show in evidence these concepts and the new functionalities they bring to ICAI systems,
- to deduce the large field of researches they offer and particularly the study of :
  - ° tutorial strategies,
  - ° problems generation,
  - ° completeness of the learner model,
  - ° and mainly, reasoning strategies jointed to the different knowledge levels.

BIBLIOGRAPHY

[CARR 77] : B. CARR, I. GOLDSTEIN, "overlays, a theory of modelling for CAI", AI memo 406, MIT 1977.
[COLL 76] : A. COLLINS, "processes in acquiring knowledge", scooling and the acquisition of knowledge, Anderson Spiro & Montague, 339-363, 1976.
[FEIG 80] : E. A. FEIGENBAUM, A. BARR, "the handbook of AI, chap IX, education, 1980.
[HERI 87] : D. HERIN-AIME, O. MASSIOT, "DEMSI, an object oriented expert system for information systems evolution", proceedings of cognitiva 87, tome 1, 236-241, MAI 1987.
[MARC 87] : P. MARCENAC, "contribution de techniques issues de l'IA à l'EAO", rapport de DEA, université de NICE, SEPT 1987.
[MINS 75] : M. MINSKY, "a framework for representing knowledge", in the psychology of computer vision, P. H. WINSTON eds, MC GRAW HILL, 211-277, 1975.

Structural Impediments to Computer Integration in Schools in the U.S.

J. J. Bosco

ABSTRACT

Recent research on computer use in the schools indicates that teacher use of the computer as a means or tool to achieve objectives in mathematics, science, language and other subjects generally is not occurring. Common explanations for this are focused on the amount of hardware available, the availability of good instructional software, and the training of teachers to use computers. This paper argues that those factors are less critical than the underlying dissonance between technology and the social/organizational structure of schools. This paper discusses the structural impediments and the implications of this orientation for improving computer use in the schools.

TEXT

There are three common explanations for the generally limited impact which has resulted from computers in schools in the U.S.: the lack of enough good software, inadequately trained teachers, and insufficient amounts of hardware (ref 1). While there is research to support all of these as problems, there is still the question of whether these three factors constitute a part or the totality of the explanation of the modest consequences of computers in U.S. schools. Will more hardware, better software and training on how to use the hardware and software generate effective use of computers in schools?

Television, 8mm film, radio, teaching machines, and even the telephone, were all touted as technologies which would improve instruction in the schools. There was considerable effort to turn television into an educational tool, but this effort has had little effect. Dirr and Pedone (ref 2) found that teachers cited the inconvenience of broadcast schedules and lack of appropriate programming as the most common barriers to use of TV. One might think the solution to these problems would have been the VCR. Most teachers know how to use a VCR, and those who do not can learn in a couple of minutes. Most schools have TVs and VCRs, both of which are less expensive than computers, and there is much excellent video software available; yet, the resolution of the perceived barriers has not resulted in significantly expanded use of video technology.

In his review of the history of technology in the classroom since 1920, Cuban (ref 3) gives a bleak assessment of the contribution of technology in schools over the past seventy years:

> The study illustrates the search for improved classroom productivity through technological innovations has yielded very modest changes in teacher practice without any clear demonstration that instruction is any more effective or productive after the introduction of radio, films, instructional television or computers. (p. 109)

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An analysis of the progression of earlier technologies in schools reveals a recurring pattern. The introduction of new technology is typically accompanied by predictions of a renaissance in schools resulting from its use. This is followed by a growing sense of business opportunity for vendors and often a perception of an opportunity for educational reformers to make use of the new technology to achieve their reform agenda. The third stage occurs with some publicized successes among early adopters but, in general, with sporadic use and mixed results. Then follows a stage of disillusionment and the downward revision of expectation. Finally, the technology settles into a niche where it is perceived as auxiliary rather than as an integral element of instruction

The basic thesis of this paper is that the fundamental problem with the integration of computers in schools is that technology--and especially computer technology--is incompatible with the way teaching and learning is structured in schools. Substantial benefits are unlikely until the dissonance in the structure of schools with the use of technology is addressed and resolved.

There is a small but useful collection of research on the social/organizational structure of schools (refs 4, 5, 6 and 7). One of the most common understandings about the classroom which emerges from this research is that the classroom is a terribly busy, active place. Jackson's classic *Life in Classrooms* (ref 8) provides a vivid documentary of the rapid pace of events in classrooms. Gimp (ref 9) estimated that an elementary teacher has over 500 exchanges with students each day. The classroom is characterized by multidimensionality, unpredictability, simultaneity and fast moving events (ref 10). What may be simple logistical problems in a more placid environment become major problems in the highly complex and active classroom. Distributing software, coping with a machine which is not working properly, coordinating student access to the equipment--all of these add demands on teachers who may feel they are already too burdened with housekeeping tasks. Within this context, the computer may be perceived more as a problem than as a resource. Good hardware, software and teacher training will not resolve this problem. The problem can only be resolved by direct confrontation of the elements in the classroom environment which create the logistical impediments to computer use.

Cuban used the term "persistent instruction" to refer to the set of instructional practices (i.e., lecturing, large group instruction, heavy use of textbook and chalkboard, seatwork, recitation and teacher made tests) which have become the standard elements in the conduct of schooling. He argues that these pedagogical practices did not randomly or capriciously occur; rather, they have been generated in response to structural features of schools such as age grading, self-contained classrooms, fifty-minute class periods, Carnegie units, multiple curricula and standardized tests (ref 4). The approaches which have become standard represent functional adaptations to the conditions which prevail in the classroom. These approaches persist in the classroom because they work; they enable the teacher to meet expectations which have been set given, the usual conditions of the classroom. The more significant and innovative uses of computers do not articulate well with the basic features of the classroom.

Another fundamental element of instruction in the classroom is that it is teacher centered (refs 3 and 11). Teacher centeredness is an important aspect of the role of the teacher. Many of the most significant opportunities for school improvement with computers would make the classroom more student centered. If the computer plays a central part in instruction rather than a minor one, the teacher is placed in the unaccustomed role of being "best supporting actor" rather than "best actor" or "best actress." A long line of educational reformers have questioned the teacher centeredness of the classroom and have attempted to foster the notion of student centered classrooms, but such efforts have not taken root because the teacher centered classroom has become widely accepted as the way to maintain order and to teach the considerable amount of instructional content which is expected to be instilled in students (ref 3).

Jackson (ref 8) and Lortie (ref 5) point out that teachers derive most satisfaction from direct contact with students. Discussions about the teacher as an "instructional manager", may seem to some an elevation of the status of the teacher by its quasi-administrative tone, but the term may be quite unappealing to teachers. It communicates a distance from direct interaction with students, which does not fit with the image of the good teacher who enlightens students with his or her ability to teach. Reduction of direct contact reduces the likelihood of the psychic rewards that come from teaching. Jackson (ref 8) reports that teachers at the elementary level talk about their outstanding colleagues with expressions such as "students adore her," or "students love her." At the secondary level, they use terms like esteem or respect. These terms indicate the importance of positive, personal, direct contact in characterizing success of teachers.

One of the capabilities of computers is to enable the formation of a "school without walls." The computer has important potential for schools as a communications device enabling wide-ranging contact with rich sources of information. Experts can provide compelling descriptions about the way telecommunications can be used in schools; yet, as Lortie (ref 5) points out, for teachers good walls mean good teaching:

> Teachers attach great meaning to the boundaries which separate their classrooms from the rest of the school and, of course, the community. Teachers deprecate transactions which cut across those boundaries. Walls are perceived as beneficial; they protect and enhance the course of instruction. (p. 169)

The implication of the conceptions advanced above is that the successful use of computers in schools entails social and organizational invention which is as important as the invention of the machines. In ordinary usage, technology has come to mean the invention of objects rather than the creation of forms. Motion picture technology means objects like camera, projector and film more than it means the cinematic conventions and approaches embodied in a contemporary feature film or the complex infrastructure required for the production, distribution and screening of films. Thomas Edison invented the motion picture projector, but he did not invent motion picture technology in its broadest, most important, meaning. Edison did not invent film as an entertainment form nor did he invent the motion picture industry. The impact of his invention was the consequence of the accomplishment of many creative persons who had the ideas and skill to make something with Edison's machine.

The common response to new technology is to adapt old forms and use an existing infrastructure. Thus, computers have made heavy use of old formats, and vendors, as well as some computer proponents, attempt to convince school personnel that the computer can be used for "business as usual." The computer is sold as a solution; but, in reality, it is more in the nature of a problem--a problem which, if solved, may result in significant school improvement. Efforts to make use of computers in significant ways in schools requires social and organizational invention which is as real and as important as the invention of the hardware. Vendors and computer experts who understand computers, but who possess a casual understanding of schools, cannot be expected to reinvent schooling in ways which take advantage of this new and important resource. Teachers and administrators need to recognize their role in inventing the processes and practices required to make the technology work in the social context of schools. The invention of these new social and organizational structures requires the involvement of inventive teachers and administrators who understand the classroom, who seek to expand and improve teaching and learning, and who are willing to use any effective tool toward the goal of the improvement of learning in schools. In their efforts, it is necessary to understand the way existing processes interact with the use of computers. Strategies for computer integration should not stop with consideration of training, back-up support, and the logistical issues directly tied to the hardware and software; rather, consideration should be given to the classroom as an organizational entity with a well-established set of traditions and practices. This requires planning which gives direct, explicit attention to the role of the computer in achieving educational goals, and this attention to the computer ought not be focused on it as a discrete, distinct entity but as it is enmeshed within the context of life in classrooms.

There are useful models of this approach whiche emerge from the office automation literature. While the particulars are different, the type of thinking about the installation of computers into the office environment does not just involve a consideration of the physical installation (i.e., where to place the, computers, etc.), but also requires thinking about their installation in an organizational sense (i.e., how they can reconstitute the office as a work place). Such thinking and planning is needed in making effective use of computers in schools. Without such planning, computers may continue to be in schools, but they will not be in schools in a complete and functional sense.

References

1. M Ploch, High Tech, Sept, 44-50, 1986.
2. M Chen, in The New Media: Communication Research, and Technology (Sage Pub, Beverly Hills, CA, 1984) pp 269-286.
3. L Cuban, Teachers and Machines. The Classroom Use of Technology Since 1920 (Teachers College, Columbia University, NY, 1986).
4. L Cuban, How Teachers Taught (Longman, NY, 1984).
5. D C Lortie, Schoolteacher: A Sociological Study (Univ. of Chicago Press, Chicago, 1975).
6. J Goodlad, a Place Called School (McGraw-Hill, NY, 1984).
7. T Sizer, Horace's Compromise (Houghlin-Mifflin, Boston, 1984).
8. P W Jackson, Life in Classrooms (Holt,Rinehart & Winston, NY, 1968).
9. P V Gump, Final Report, US Office of Education, Bureau of Research (ERIC Document Reproduction Service #ED015515).
10. W Doyle, in Handbook of Research on Teaching (Macmillan, NY, 1986) pp 392-431.
11. R S Adams & B J Biddle, Realities of Teaching: Explorations with Video Tape (Holt, Rinehart & Winston, NY, 1970).

COMPUTERS AND ROBOTS IN EARLY CHILDHOOD EDUCATION: TOOLS FOR BASIC SKILLS

Trisha Ainsa, Ph.D.*

ABSTRACT

Classroom children ages 3 to 9 served as experimental and control groups for introducing computer literacy, computer concepts, and basic skills computer curriculum into the regular classroom. The topics included keyboarding, basic skills, software, SAVVY (a programming language), and robotics. Teachers and parents were trained and evaluated. Results showed that children who had knowledge could use the computer and program the robot successfully.

INTRODUCTION

The back to basics movement in American schools has resulted in two major shifts in early childhood writing and research. There has been a shift from an emphasis upon the written product (e.g. handwriting skills) to a focus upon the process used by children to become proficient writers. Interest in the origins of writing has shifted attention to how younger children acquire the skill of writing (ref 1). The second major shift is that of integrating information and technology and problem solving into the acquisition of basic skills. Freeman, et al (ref 2) states that "We are moving into an information-based society and that people who have information have some kind of power. We need to make that power accessable to our classroom children.

OUTLINE OF STUDY AND METHODS

In Fall of 1983, twenty-five , four and five year old demonstration kindergarteners participated in pilot testing computer curriculum materials. Since then, 735 children from four different school districts, pre-school to third grade, have participated in computer curriculum

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studies. Children attend Head-Start (Pre-school for Limited English Speakers) and public kindergartens, as well as grades one through three. The pre-school and kindergarten children were primarily exposed to introductory computer activities, keyboard familiarization, introductory programming and readiness skills software. The grade level children utilized more keyboarding, word processing, and computer assisted instruction for basic skills.

The kindergarten computer curriculum started the children at "ground zero" knowledge of computing and kindergarten skills and progressed to a beginning level of computer and keyboard familiarity. Beginning curriculum included identification of alphabet letters, numbers 0-10, knowledge of left and right, and special function keys. Children also learned about chips, ROM, CPU, RAM, and peripherals. A simulation turtle was used to teach an early childhood version of LOGO.

The children were introduced to robotics using RB5X, an educational robot. They programmed the robot using SAVVY. SAVVY is an artificial intelligence programming language that uses real words to communicate with the computer (ref 3).

Lessons in handling software diskettes, were incorporated. Two different types of school settings were utilized to test the curriculum programs for second and third grades. In one school seeting, (Environment A) there were computers available in the classrooms. The other envionment consisted of a shared computer laboratory situation (Environment B).

Curriculum materials consisted of some published materials (Computergarten (ref 4) and Rainbow Keyboarding (ref 5)) utilized for keyboarding instruction; teacher-made materials which emphasized required grade level curriculum and basic skills; and materials developed by Computer Literacy In Children curriculum specialists (a grant-funded by the U.S. Department of Education).

RESULTS

The Analysis of Variance statistics for the Head Start (Pre-Kindergarten groups) are listed below. These groups represented unmatched subjects and an unequal number of subjects.

Table 1 Summary of Head Start ANOVA

Ho = There is no significant difference in the test scores of the experimental groups and the control groups.

Experimental number of scores - 103
Control number of scores - 82
185

Control Mean = 28.06
Control Variance = 520.91
Experimental Mean = 42.06
Experimental Variance = 1071.73
F = 10.69 df 1,183
At a .0025 confidence level, the critical value of F = 9.9
10.69 > 9.9
F is significant, therefore, we reject the null hypothesis

The results of the U.T.E.P. Kindergarten pilot program, including twenty four children (Anglo, Hispanic, and Limited English Speaking), are best summarized using progress and curriculum analysis charts. The students were grouped by age and ability into two equal numbered groups One child of the original twenty five left the U.T. Kindergarten after one month of the curriculum and therefore was not included in the final evaluation. The control group consisted of 25 children in a similar Kindergarten class. The progress chart below indicated pre- and post-test percentages of each group. The children were asked to perform the tasks in the curriculum units and graded on a pass-fail basis.

Units	Group 1 (12 students)		Group 2 (12 students)		Control Group (25 non-experimant kindergarten subjects	
	Percentage of students succesfully completing units.					
	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test
1. Names all the keys on the keyboard	25	100	0	100	30	50
2. Jumps on the Keyboard-On-The-Floor	0	100	0	100	0	0
3. Pushes all the keys with the correct finger	0	75	0	100	0	0
4. Knows What Magic Function Keys do	0	100	0	75	0	0
*5. Follows Basic Bears flowchart path	0	100	0	100	0	0
6. Makes a Flowchart	0	100	0	50	0	0
*7. Copies a program in BASIC	0	50	0	0	0	0
8. Tells TodoLogo how to move in LOGO	0	100	0	100	0	0
9. Copies shapes in LOGO	0	100	0	75	0	0
10. Loads diskette and handles software properly	0	100	0	100	0	0
11. Understands TodoLogo's Compass	0	100	0	75	0	0
12. Walks through a computer and tells you how it works	0	100	0	100	0	0
13. Knows "computer words"	0	100	0	75	0	0
14. Programs the Robot "RB5X" in SAVVY	0	80	0	75	0	10

The progress chart below indicates pre- and post-test gain percentages of the second and third grade groups. The children performed the tasks as outlined in the workbooks and were graded on a pass/fail basis. Children in Environment A achieved maximum success on all activities included in the curriculum as well as an overall typing speed of 15.7 words per minute with accuracy that could be considered adequate. Children in Environment B achieved substantial success overall, with some classrooms achieving more than others (depending on how much time the children practiced in the classroom and at home). The scores for time tests ranged from 11 words per minute to 16.6 words per minute.

	Percentages of students successfully completing task					
	ENVIRONMENT A			ENVIRONMENT B		
SKILL	Pre	Post	Gain	Pre	Post	Gain
IDENTIFIES COMPUTER PARTS	0	100	100	0	0	100
HANDLES DISKETTE PROPERLY	3	100	97	5	100	95
USES CORRECT KEYBOARD POSITIONING	0	100	100	0	100	100
KEYBOARDS ALL LETTER KEYS ACCURATELY	0	80	80	0	84	84
KEYBOARDS NUMBER KEYS ACCURATELY	0	73	73	0	65	65
KEYBOARDS SPECIAL FUNCTION KEYS ACCURATELY	0	85	85	0	80	80
KEYBOARDS WORDS/SENTENCES	0	100	100	0	95	95
USES A FLOWCHART	0	97	97	0	86	86
KEYBOARDS BASIC PROGRAMS	0	100	100	0	100	100
KEYBOARDS LOGO PROGRAMS	0	100	100	0	100	100
UTILIZES COMPUTER IN CONTENT AREAS	0	95	95	0	90	90

REFERENCES

1. J. Harste, C. Burke, Child Dev, 49, 123 (1978)
2. C. Freeman, et al, Cent for Child and Tech (Bank Street College, N.Y.)
3. N. Delgado, Robotics Age Mag, Sept., 1984
4. T. Ainsa, Computergarten, (Scholastic, N.Y., 1985)
5. T. Ainsa, Rainbow Keyboarding (Scholastic, N.Y., 1987)

PERSONAL BELIEFS AND CLASSROOM PRACTICES: USING TECHNOLOGY AS A TOOL FOR PUTTING OUR LIVING AND LEARNING PHILOSOPHIES INTO EFFECT

Hillel Weintraub

ABSTRACT

In this paper I would like to address the importance of developing our self-awareness in order to bring about a greater agreement between what we say we believe in -- our philosophies -- and what systems our learning environments actually support. Specific examples are given of how one teacher tries to do this and how we can share experiences and support each other in developing congruent environments.

INTRODUCTION

For the purposes of this paper, there's an important distinction to be made between being guided by an unconscious philosophy and acting with awareness of what is guiding us. When we are operating without any awareness of what beliefs are guiding us, then basically we have given up control over our actions and thoughts. If, however, we develop an awareness of our actions and the beliefs they support, then we can move towards putting our actions more in line with our spoken philosophy.

The racial, cultural, familial, and personal forces that work on us usually operate at levels below our consciousness so that we tend to act out of habit rather than plan. In modern society, another powerful force, that of a general social momentum, has become a key factor in influencing unconscious behavior. Without self-awareness most of our patterns of action support this materialistic, technocentric values which those of us living in so-called "advanced" nations are continually bombarded with by the media.

This means essentially that we will support quantitative rather than qualitative criteria; we will use numbers and objective criteria to support our ideas rather than words and subjective criteria; we will evaluate outer packaging to be more important than inner content; and we will equate progress and success by monetary and technological status.

For teachers in a classroom, under great pressure for their time and energy, working without self-awareness means teaching the way they were taught -- mostly in classrooms with an authority standing in front, dispensing information like mother birds dropping worms down their babies' throats. And, of course, students are sitting there like so many baby birds, noisily chattering, stopping their racket only long enough to open their mouths for an occasional worm to be dropped in.

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THE IDEALIZED vs THE REAL

Recently at an English teachers conference in Kyoto I asked a number of teachers what their purpose in teaching was. All of the responses I got expressed ideas like wanting to help their students "understand the world better", "build a peaceful world", and "learn how to express themselves." I didn't get one response which said anything about "grades", "getting into a good college," "developing perfect grammar" or "memorizing a lot of words." Yet if we were to walk into any classroom, look at any homework assignment or exam, observe what each moment's energy is directed towards, what would we see? We would see that, at least in most English language classes in Japan, the idealized philosophy and the day-to-day practice not only don't match, they don't even come close!

In order to move towards developing teaching environments which support our goals, the first thing we can do is develop the ability to observe ourselves and evaluate our actions. We also need to get together with like-minded colleagues so that we can support, give feedback to, and get feedback from each other.

PHILOSOPHIES I SUPPORT

Three of the philosophies which I am interested in supporting in the learning environments I create are:

1) The idea that everything -- teachers, students, knowledge, learning activities -- is in the process of being one thing and becoming something else, and, in the sense of its incompleteness, is also imperfect.
2) The idea that thinking and personal skills which allow students to be critical, creative, and independent are worth much of our classroom energy and attention.
3) The idea that cooperation rather than competition is both wise in this information age and mandatory in this nuclear age.

Let's look at some of the ramifications that the idea of the changing nature and thus imperfection of thoughts, actions, and people, can have in a classroom. First of all, it must instill a great sense of humility in everyone involved in education (and everything else as well!) Since all we are saying or know is just part of what is to be known, it is also, in a sense, a lie if we try to present it as **THE** way or **THE** answer.

Secondly, in an environment that recognizes the changing nature of knowledge and knowers, giving energy to understanding learning processes become more important than learning any particular content known at one time. In order to help my students look carefully at how they learn, part of their activity -- whether reading, writing, discussing, thinking, or programming -- includes observing themselves or their peers as learners. Vacation homework projects include things like learning to juggle or taking apart and putting together a complex metal puzzle and keeping a journal as they observe their feelings and actions while learning something quite new.

We give much attention to the nature of learning, what it means to different people, and how our actions show what it means to us. Students make tests both for themselves and for others. I ask the students to grade themselves and think about the criteria which they use for their evaluation.

I try to help students become aware of their tendency to want to "know" an answer rather than think about the question or understand a process. Dealing with this tendency is one place where a teacher's own self-awareness can make a big difference. Quite unconsciously, most teachers will answer any question a student asks, even happily because usually students don't bother to ask questions, except before exams.

Would it be too dramatic or shocking to say that for every question we answer for a student, we take a step in the direction of creating a slave mentality, rather than a self-confident, independent thinker? Can we see how answering questions gives much reinforcement to the idea that getting a right answer is more important that the process of working it out. Great damage is done by this practice, which can be compared to giving a hungry person a bowl of rice rather than teaching her how to plant and harvest seed.

In order to help students plant seeds, I have made an effort to develop an awareness in myself of how I respond when a student asks me a question. I've tried to change my image from a person who passes out information to a person who helps other people find out what they want to know. I've taught myself to ask the student to identify clearly what she doesn't understand. Is it information that isn't known or the process of what to do next that isn't clear? It's surprising how often students don't know what they don't know. When they are helped to find out, my experience is that more than 80% of the time they are able to work well towards finding an answer, and, in the process, develop confidence in their own problem solving ability. At the same time,they are developing a new experience about the meaning of "learning" something.

I also don't allow erasing in most situations. Students in my class and at home always have to use two colors of pencils or pens. One color is used for their initial effort; the second is used to show any corrections or changes they have made themselves. More than neatness, I value an active mind as shown by a paper which has many additions on it. Since I value process I want to see the changes which a student has gone through in doing his work, and I want the student to be aware of this process as well.

By having students put away their erasers, leave their own original answer and write additional answers or ideas, they change the "I was wrong; this is right" concept to "My idea can be supported, and this is another possibility" or "My first idea can't be supported as well as this one, but it has some value and I want to leave it to show how I moved from there to here." We can see that the "no-erase" custom supports the idea of learning as a process which we value.

CHALLENGING AND COOPERATIVE

In a society described as "the most manipulative culture human beings have ever experienced" (R.Scholes, Textual Power, Yale University Press, 1985), what can we do to help prepare our students to be responsible citizens of the present and future? Be good memorizers? Take in what one person or one machine says and accept it as "learning" in order to pass an exam? Surely we can see that the effect of such behavior is to reinforce the present momentum of society towards creating people who pass through our educational institutions without learning to think clearly or challenge what is presented to them.

In order to get our students ready for the future we need to teach them to challenge and doubt what they read and hear. I don't want my students to trust, depend on or automatically believe anything anyone says, so I start with myself and my relationship with them by creating an environment where they can feel safe to criticize me and their classmates. I often deliberately make mistakes or try to trick them so that they can never stop thinking for themselves. Sometimes I write or speak nonsense and shout at them when they swallow it in without noticing. In my Logo programming class as soon as they know some commands I start to misuse them, filling my procedures with enough bugs to keep them awake.

Because it's important for them to value their own opinions and experience and those of their peers as well as those of so-called "experts", much time is given to helping them express their own ideas clearly.

TECHNOLOGY: SUPPORTING OUR PHILOSOPHIES

There is little space left and deliberately I've said almost nothing about technology. (I tricked you with my title,didn't I?) Most of us start with computers and think, "How should we use them?" I believe that we should start with our beliefs about what education is and what kind of environment we want to nurture students in. Then we will know how to use computers and technology to support us.If we believe that learning means memorizing or pretending that problems have only one right answer, then we can find software to support that idea.

If we believe that learning involves teaching and looking at processes, computer uses which allow that will be discovered. If we believe that kids communicating with other kids across the city, country or globe about things they are interested in, can provide great learning possibility then we will find a way to use technology for that, too.

But basically you can see that technology has nothing to do with instituting a philosophy. It is the teacher who creates the mood and environment, which is why it is important for us to develop awareness of our goals and how to implement them.

From this paper, hopefully, my interests are clear.If readers have similar interests, especially regarding language learning environments and telecommunication, please contact me.

ADAPTING TECHNOLOGY TO ORDINARY USE

Martin G. Heltai*

INTRODUCTION

Since the end of World War II education has developed a strange love affair with Technology . Many saw technology as the answer for making education efficient and effective on a very large scale. This promise however has not been fulfilled. The failure has not been a failure of technology but a failure of adaptation. First because to a large extent Education is disillusioned from the promises of technological quick fixes, and second because we have a very poor system for understanding the various technologies, and very little understanding of the process of adaptation. This fascination with the possibilities technology can offer the educational process in not strictly an American one though I believe it is much more pronounced in the United States than anywhere else in the Western world.

Past studies of the role of technology in education have tended to concentrate either on the invention itself or on its impact (or potential impact) on education. Very little attention has been given to the process of adaptation required to usher a new technology to ordinary use. As we all know the introduction of new technology or indeed any new idea into an educational system requires a great deal more than just the communication of that new methodology, It requires radical psychological change preceded by a struggle of ideas.

One could spend many hours listing all the technologies presently and potentially involved in the educational process. The technology this paper covers overlaps three areas. The first is obviously computers. The second Audio and Video production , and last is the publishing. At first glance these three areas seem unrelated, however in the past two years there is a growing overlap between these three fields. One only needs to look at the progress of desk top publishing the capacity to randomly retrieve visual information, the capacity to digitize sound and pictures as well as the progress made in the field of voice recognition. It is not difficult to see that once these technologies begin to blend, the way we our society will transfer information will be totally different than in the past five centuries.

The analogy between the revolution that the printing press created and the potential revolution of computers are perhaps too often made. The printing press was revolutionary not only because as Gütenberg imagined, it would be a tool to efficiently disseminate information, but because the advent of the printing press fundamentally changed almost every aspect of our life. Indeed no other invention that has had as great an effect on our civilization. Perhaps in hindsight we will recognize the same thing about the computer. This revolution, however is still only a potential and as there are great potential opportunities, there are great dangers. The opportunity is that this new technology is a "tabula rasa" for our individual and collective imagination. The danger is that we could create a society where we will be divided into a small elite with the resources to interact through technology,

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**Martin Heltai is the director of Media Services at The University of Texas at Arlington, UTA box 19647 Arlington, Texas 76014 USA* and the large masses incapable (perhaps uninterested) but passively dependent on technology.

MAKING TECHNOLOGY ORDINARY

The perceived problem in the integration of technology into education, indeed into every day life is that the rate of development in technological products far outstrips our capacity to absorb them. Perhaps the problem is that we are enamored with new technology rather than adapting appropriate technology to the process of teaching and learning and allow the new innovation to organically change the process from within.

For the sake of this abstract I will divide education into two components. The process of instruction - imparting and acquiring instructions and the process of signification - arriving at new understanding and new questions. Instruction being somewhat a quantifiable and thus measurable element and signification being very difficult to quantify and measurable only by inference. In an ideal world the process of acquiring information awakens in the learner a new understanding developed by the synthesis of the information and arriving at a conclusion independently. This process of discovery is the most satisfying human endeavor and indeed the reason for the progress achieved in our society in science and technology as well as the humanities. This capacity for discovery is inherent in all human beings (except those with the severest mental disability). Unfortunately this capacity is wasted to a large extent because our system of education has a tendency of identifying and promoting an elite based on the capacity to perform well in school. Because of the mass education expectations of our educational system the desired goals of addressing the individual students learning style in order to develop most students innate abilities for thinking, imagination and creativity can not be addressed efficiently. The result is that a significant portion of students who journey through the formal education system end up disenchanted and discouraged.

The possibilities for individualizing instruction in order to develop many learning styles has been with us for many years. Yet not even the computer which has all the capabilities to address this issue at a reasonable cost has had a major impact on the individualization of learning. Nor for that fact has any of the older highly touted technology such as films television the teaching machine to mention a few. The problem was not that these innovations were not adequate, or that the innovations became obsolete too quickly, indeed all these technologies still have enormous unmet potential to impact the educational process. The problem is that these innovations were introduced with great fanfare and only a few pieces of this hardware were made available to a select number of classrooms. These few projectors, videotape playback systems and computers cannot fundamentally change the process of education because they are nothing more than a minor enhancement at best. They are extraordinary.

The analogy between the revolution started by Johann Gütenberg's printing press and the computer revolution are striking. The revolution is not the computer itself since it has been around for more than forty years. The revolution is that it is becoming more widespread. Indeed in developed countries such as ours one cannot escape the use of microprocessors. However the uses of these systems are still too prescriptive and the hardware still too precious. In order to bring technology to ordinary use, the technology has to become trivial. It must silently serve the creative imagination of humanity.

The steps required for the large scale integration of technology into the educational process are; first to educate a population capable of using the technology and encouraging the creative endeavors through this new medium with as little prescription as possible. In the case of computers this means that computers must be available to the artist and the writer as well as the scientist and the businessman. Second The technology has to become non-precious and available as an ordinary everyday tool of the classroom. And lastly we have to look at how technology can enhance the fundamental processes of teaching and learning organically rather than prescriptively.

A LOOK INTO THE FUTURE

In conclusion one has to look at the future and how technology could change our educational system. The fundamental change will occur in our capacity to tailor information to individual needs and requirements. This will be possible through the continued integration of computers, communication and data banks that contain audio, visual as well as written information. There is very little doubt in my mind unless there is a cataclysmic political or economic event that within the next decade the computer will become as much a part of the student and teachers tool box as books paper and pens are today. The combination of these two factors will create an environment where the way we communicate with each other will drastically change. This in turn will affect every aspect of our life as much as Johann Gütenberg's invention changed our life since the fifteenth century. The difference is that the pace of the changes in this new revolution will be measured in months and years rather than decades and centuries.

MANAGING INFORMATION: SECURITY, ACCESS AND DISSEMINATION - A CASE STUDY

Roy K. Bhagaloo*

ABSTRACT

The rapid expansion and utilization of computer resources have been significant and at a time when certain interrelated factors must be taken into consideration. Among these are the information age, information as a corporate asset, corporate data base, data communication, and security and reliability of the organization's information. In considering these factors, it can be substantiated that there is a need to plan and implement a system to permit accessing, disseminating and securing information in such a way as to satisfy and accomodate the implications of these factors. This paper presents a case study of such a system.

INTRODUCTION

The rapid expansion and utilization of computer resources must take into account, satisfy and accomodate the implications of certain interrelated factors among which are the information age, and the recognition that information is a corporate asset and must be treated as such. Additionally, and perhaps the most significant is the concept of the corporate data base which recognises information as being owned by the organization as a whole and that information should be made available to everyone on a timely basis, according to job needs. Another factor is the perception that the role of data communication is escalating and becoming increasingly vital in disseminating information throughout an organization. Finally, there is the proposal that the organization's information be secure, reliable and made available to satisfy job requirements.

The case study presented in this paper represents a system currently in operation in the Muscogee County School District (MCSD), satisfies and accomodates the implications of these factors and is referred to as the Information Management System. The case study, as presented, is limited to an identification of the system's components within the context of an implementation guide. A description of the conceptual model on which the system is based may be found in the proceedings of the joint conference of the Association for Educational Data Systems (AEDS) and the Educational Computing Organization of Ontario (ECOO) held in Toronto, Canada, April 21 - 26, 1985.

OBJECTIVES AND COMPONENTS

The objectives of the system are to facilitate the use of, and promote access to, the MCSD's data base while limiting access to authorized users. Additionally, the system ensures the security, monitoring and tracking, and accountability related to the operational aspects of the MCSD's data base. The components of the system are the following five: Data Base and Screen Format; Location/Operating Unit Numbering

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Scheme; Terminal Numbering Scheme; Password; and Monitoring and Tracking Scheme. A description of each follows:

DATA BASE AND SCREEN FORMAT

This component deals with the design of the data base and screen format. The format is hierarchical and menu driven with the menu being the lowest in the hierarchy and designed to display a group of functionally self-contained data. The component has the following three levels in its hierarchy in descending order of magnitude: Index Listing, Menu Listing and Menu Data Screen. The Index Listing contains a list of all the information systems comprising the data base; the Menu Listing contains a list of all of the functionally self-contained data groupings within a selected information system; the Menu Data Screen displays the specific data elements for a selected functionally self-contained data grouping. For example, the Index Listing shows a list of information systems including Student Management, Personnel, Financial Accounting, etc. The Menu Listing for the Student Management System shows a list containing the folowing data groupings: Demographic, Assignment, Attendance, Exceptional Student, Special Testing, Health Certification, and Discipline. The Menu Data Screen for the Demographic Menu contains the following data elements: Student name, address, student number, telephone, sex, race, parent's name, school, teacher, and birth date for an individual student.

LOCATION/OPERATING UNIT NUMBERING SCHEME

This component represents a standard location code for the MCSD. It is designed to reference several codes for the same location which currently exist in different user departments. It does this by "tabling" all location codes for the same location to the standard location code for the particular location in question. The numbering scheme for this component is hierarchical and contains three levels which are, in descending order of magnitude, as follows: Type of Location, Location Group Category, and Individual Location. The highest level includes the following seven types: Schools, Administrative Support, Community Support, Auxiliary Support, Private Schools, Fort Benning, and Miscellaneous. The second level includes several Location Group Categories under a particular Type of Location such as senior high, junior high, elementary, post-secondary under the location type: "Schools". The third level contains the individual location within the Location Group Category for a particular group. For example, all of the elementary schools are included under the Group Category: "Elementary Schools". The numbering scheme used in this component is a four digit number which is inclusive of all three levels of the hierarchy. For example, the Type of Location for "Schools" is 1000; the Group Category for "Secondary Schools" is 1100; the Individual Location for Baker High School is 1101. Thus the 1100 series represent the senior high schools, the 1200 series the junior high schools and the 1300 series the elementary schools. The 1000 series represent, of course, all schools.

TERMINAL NUMBERING SCHEME

This component deals with a numbering scheme to permit the identification and monitoring of each terminal accessing the MCSD's data base. The numbering scheme establishes a unique number for each terminal by combining the location number with a sequential number for each terminal within the location. The serial number of the terminal is identified in order to interface with the MCSD's Equipment Inventory System so that detailed information may be received should the need ever arise.

PASSWORD

This component is designed to permit users to access appropriate segments of the MCSD's data base. The pasword is a fixed length aphanumeric word which interfaces with the MCSD's Personnel System to identify the employee who holds the password. The password is embedded with three variables, the first being the data base (menu data screens). The limitation of this variable may range from one to twenty data menu screens for a particular information system and may be extended to all data menu screens for all information systems comprising the Index Listing described in the Data Base and Screen Format section. The second embedded variable is the type of access capability to permit the reading or writing (updating) of data at the data menu level. This variable also accomodates a high of all data menu screens of all information systems to a low of one data menu screen of one information system. "Write" access is limited to selected personnel within each user department and "read" access is given to all personnel who need the data. The third embedded variable is the location/operating unit access capability with the limitation ranging from a low of one to ten individual locations to a high of ten hierarchical location codes described in the Location/Operating Unit Numbering Scheme section. A password may be embedded with a maximum of ten location codes which could include all locations. For example, a password could be embedded with one location code "1000" which represents "Schools" and could then access the files of all fifty-four elementary and secondary schools in the MCSD.

MONITORING AND TRACKING SCHEME

This component deals with monitoring and tracking the terminals, data base and password for usage and security violations. This component operates by maintaining two records, one for each valid password and the other for each terminal. The password record keeps track of the number of times the password is used for each terminal, each data menu screen and each security violation. It also maintains the MCSD's "journaling" transactions which operate as follows: Whenever a user updates a record, the name of the person (password), terminal identification, date, time of day, and "before" and "after" images of the data elements updated are recorded. The second record maintained by this component is the terminal record which keeps track of the number of times a terminal has been used for password violations.

The MCSD's Information Management System generates the following four reports: Terminal Usage Summary which shows the month-to-date (MTD) and year-to-date (YTD) usage, data security and password violations for each terminal; Personnel Usage Summary (alphabetic and by location) which shows each employee's total MTD and YTD usage and data security violations for each information system in the MCSD's data base; Information System Summary which shows the total MTD and YTD usage and data security violations for each information system; and Journal File Activity which shows the information described in the previous paragraph for journaling transactions.

SYSTEM OPERATION

The system operation is initiated by the user. When a user enters a password, the system checks the Password File to determine if it is a valid password. If it is not valid, the system issues an appropriate message on the screen and logs the password violation against the terminal in the Terminal File. If, on the other hand, the password is valid, the system checks the Password File to determine the data base, type and location access authorization of the password and matches this information with the user request. If the request is not authorized, an appropriate message appears on the screen and the data security violation is logged against the terminal, password and information system. If the request is valid, the user receives the requested screen(s) and the usage information is logged against the terminal, password and information system. Additionally, if the action is to update, the system logs all appropriate data in the Journal File if it is an authorized action, but gives an appropriate screen message and logs data security violation data against the password if the action is not authorized.

SUMMARY

The Muscogee County School District's Information Management System with its five components of Data Base and Screen Format, Location/Operating Unit Numbering Scheme, Terminal Numbering Scheme, Password, and Monitoring and Tracking Scheme is designed to facilitate and promote access to the school district's data base while ensuring security and accountability. The keys to the system are the Password and the Password File. The former embeds the user's data base, type (read or write) and location/operating unit access authorization while the latter logs all usage, security violations, and journal transactions.

TAXONOMY OF EDUCATIONAL SOFTWARE APPLICATIONS

Yehoshafat Shafee Give'on*

THE EDUCATIONAL APPROACH

The pre-computer media classifications have usually stressed the characteristics of the stimuli provided by the medium and neglected, to a certain degree, the holistic educational characteristics of the activities involved with technology based media (cf. ref 8). These methods have been transported to the domain of software evaluation, where software is regarded still as stimuli generating media.

However, these methods were suitable only for a very narrow use of the computer potential as a tool for teaching and learning. Our concepts of the use of interactive software as an educational tool have changed in the last years. They have developed from the naive and limited view of automated stimuli generation and programmed instruction to a very broad spectrum of different categories of software applications.

In spite of the confusions that still exist in many educational systems concerning the use of computers, a certain uniform pattern begins to emerge. Using different terminology, most authors of current literature when discussing the scope of software applications in education, converge upon a common linear scale for these activities.

It seems that most of us agree that the simplest of all software based educational activities is the delivery of fully automated drill and practice. Slightly above this we locate the tutorials, which are automatic information delivery programs.

Next in line in sophistication come computer games and simulations. Here the pupil has to lock horns with algorithms, or with principles represented by means of algorithms. These activities are quite similar and, often, cannot be distinguished one from the other.

The use of generic programming systems has to be considered next. These are word processors, image or graphic processors, data base generators, electronic spreadsheets, turtle-graphic programming systems, geometric construction sets, authoring languages, and even computer games that include composition features.

We have to distinguish between the use of the applications generated by such tools and the use of the generic programming systems themselves. The use of a ready-made application (e.g., a ready-made database or a programmed spreadsheet,) should be classified as a use of any other computer software, that is, depending on the actual educational modality of the activity. Teachers who are not taught how to use generic software in their class in open construction activities, are liable to use ready-made applications generated by these tools in activities that are actually semi-automated tutorials ("get the information") or at the best, directed exploratory learning ("find the rules behind these data"). It is not the tool that make the difference in the educational mode of the activity.

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Only when the pupils themselves are involved in the process of the construction of the particular information structures as provided by the given generic system, they can be involved in a level of learning activity and experience which is much higher than all the previous ones.

The most sophisticated and controversial learning activity that involves the use of software in school is that of "expressive programming". This is a particular type of programming which serves as a method of expression of ideas concerning structures, processes and systems (ref 1, ref 2, ref 3 and ref 10) rather than as a method of transforming a computer into some very practical and special purpose machine. At this level of activity, the programming activity itself is used mainly for cognitive and aesthetic purposes. Following Salomon's analysis (ref 11) we may say that the programming languages that can be used in such an activity must be tools that can turn cognitive.

The terms of reference by means of which the basic computer related educational activities are classified in the literature are quite diverse. We can find references to the role of the computer such as in the famous title of Taylor's book in the order which agrees with the above scale (ref 13). The role of the pupil is delineated by Chandler in full agreement with the above (see ref 6). The role of the teacher can be seen to become more and more involved and demanding as we go up the above suggested scale (ref 7). It is somehow surprising to realize that Bloom's taxonomy of cognitive objectives (ref 5,) can be used to characterize these activities, yielding the same scale (ref 4 and ref 7). The type of learning experience provided for the pupil by activity can also serve as a yardstick for the above (ref 12). The instructional model or pattern, according to Lam's analysis of the logics of instructions (ref 9), applies very well to this scale (ref 7).

While it is certainly foolhardy to predict future developments in a field as dynamic as the field of computer applications, current trends in the attempts to apply AI methods to education seem not to be able to change our views concerning the basic software applications in teaching and in learning. In simplistic terms, the application of AI methods to software based education can affect one or more of only the following facets of educational activities. The software may augment the learning environment. It may augment or replace the teacher. And/or it will effectively cut corners for the learner. Therefore, as long as we maintain our existing concepts of learning and teaching, the possible AI contributions to educational activities will be still classified in terms of the pupil's role, the role of the acting teacher, the cognitive objectives of the activity per Bloom's taxonomy, or the type of instructional pattern involved.

AN INFORMATICS BASED APPROACH

There is another perspective that may further illuminate this suggested classification of all known educational applications of software. Naturally, it will have to overlap with some previous characterizations, but it can be defined independently. The idea is to characterize the educational software applications on the logical and computational types of the information which is exchanged and processed in the interaction between the learner and the software.

This characterization can be based on the answers to the following three questions:

1. What type of information is required from the learner in order for the software to function and for the activity to proceed properly ?
2. What type of information is provided by the software as the data for the learning process designed for the activity ?
3. What minimal level of information processing is required from the learner, using the information provided by the software, so that the learner will attain the objectives for the activity, ?

In Drill-and-Practice activities and in the Automated Tutorials, the educational activity itself is based mostly on the quality of the information provided by the software. In Computerized Games and Simulations, the quality of the two types of information are equally important. Generic Programming Systems and Expressive Programming become high-level educational tools only as a result of the information provided to the software by the learner.

These statements can be verified also by examining the prerequisites that have to be met by the source of the software concerning the knowledge of the materials taught by, or with, the software. The more we go up the scale, the less amount of subject matter data is required for the programming of the software. You cannot program a Drill and Practice piece of software without subject matter data, but you can program a Turtle Graphics program without being even aware of most, if not all, of the data that can be learned from using Turtle Graphics about Symmetry or about Intrinsic Geometry. The low-level activities require software which is based on, or that can automatically generate, explicit subject matter data. The higher level activities use software which is based, at the most, on very implicit subject matter data. Obviously, the more implicit are the subject matter data, the more demanding the software is in terms of the information processing that is required from the learner. This does not means simply a higher level of difficulty, but a higher type of information structure. What we need here is an insight into the structural relationship that holds in each learning activity between the flows and types of information involved in the activity. This leads us to consider the answers to the third question.

In Drill and Practice activities, the learner is not supposed to work something out of the output of the software. The questions or exercises provided by this type of software are not supposed to be riddles or puzzles. If they are, the activity is not Drill and Practice. The user in a Drill and Practice activity is supposed to respond to the questions according to his current level of performance. His responses must have direct logical relationship to the questions or the drills. He is asked about something and he is demanded to provide that something.

The learning activity using Tutorials is similar to D & P activity except for the fact that the software is supposed to provide the data to be learned by the learner. Yet we do not expect a tutee, during such an activity, to develop something which is removed from the data provided by the software. He is expected to receive data and mostly to recall them.

In Computer Games and Simulations, the user receive data from the software and inputs data back to it, but he/she is expected to look into possible relationships between these data. The pupil is expected to discover and to learn the relationship, or the algorithm, that exists behind the observed data.

In the higher level use of Generic Programming Systems, the pupil is expected to raise one level above the discovery and learning of a relationship between the observed data. Here the pupil is expected to construct various specific patterns, or algorithms, in order to generate structures of the observed data. Thus, his/her attention may be directed to the study of the structure of different representations of information. For example, the proper use of the elementary part of Logo, at this level, would be the construction of various REPEAT commands that generate rotational symmetry and the study of the relationships that exist between the forms of the symbolic patterns in the commands with the structural relationships that hold in the geometric structures produced by them. A similar approach can be applied to any generic system used for higher level of learning.

In Expressive Programming activities the student is expected to compose programs that express his perception and understanding of common underlying structures of several types of information even in several domains of learning. In other words, the student is directed to conduct a study of concepts related to formalisms, very much in the style of the theoretical parts of Computer Science or Informatics, or like in mathematical research.

One of the immediate consequences of this analysis is the realization of the existence of a certain rapprochement between the field of Computers in Education and the most theoretical parts of Computer Science or Informatics. This realization may change the existing conception of "Computer Literacy" especially when applied to teachers training. Another possible consequence that may ensue would be a better understanding of what to look for in empirical research concerning the educational value of various software related activities. Furthermore, an additional outcome could be a better understanding of what an optimal educational programming language should be like. These three issues deserve separate additional discussions.

References:

1. Abelson, H., Sussman G. J. and Sussman J., Structure and Interpretation of Computer Programs, (MIT Press, Boston, 1986) p. xv
2. Allen J., The Anatomy of Lisp, (McGraw-Hill, NY, 1978)
3. Allen, J.R., R.E. Davis and J.F. Johnson, Thinking About [TLC] Logo - A Graphic Look at Computing With Ideas, (Holt, Rinehart and Winston, 1984)
4. Berg, P.K., "Computers in the Schools of Rural Alaska", in Intelligence School House, (Ed. D. Peterson, Reston Publishing Co. Inc., Reston, 1984) pp. 225-236
5. Bloom, B.S., Taxonomy of Educational Objectives, (D. McKay, NY, 1956)
6. Chandler, D., Young Learners and the Micro-computers, (Open University Press, London, 1984)
7. Give'on, Y.S., "Applications of Computers in Education: Dimensions and Consequences", Dapim, 5, pp. 5-16 (1987)
8. Heidt, E.U., Instructional Media and the Individual Learner, (Nichols Publishing Co., NY, 1976)
9. Lam, Z., Contradictory Logics in Teaching, (Sifriat Poalim Ltd., Israel, 1980)
10. Papert, S., "Computer criticism vs. technocratic thinking," Educational Researcher, 16, 1, pp. 22-30 (1987)
11. Salomon, G., "AI In Reverse: Computer Tools That Turn Cognitive", CCORE Technical Report, No. 10 (Tel Aviv University, School of Education, Israel, 1987)
12. Solomon, C., Computer Environments for Children, (MIT Press, Boston, 1986)
13. Taylor, R., (ed.) The Computer in School: Tutor, Tool, Tutee, (Teachers College Press, NY, 1980)

TRENDS AND ISSUES: IMPLICATIONS FOR LEADERSHIP

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ABSTRACT

The recruitment and preparation of those who will lead education into the third millenium takes on a new significance as societies move into the microelectronic age. There is a need for the preparation of educators and school leaders to include literacy about the nature and consequencies of the microelectronic revolution, to prepare educators to respond to the coming changes in schools' structure brought on by the advanced technology age and to continually reeducate school leaders in new ways to synthesize the magnitude of information now available.

TRENDS AND ISSUES

Today, the stakes for society looms great as we look ahead. We will either emerge into the 21st century as an Orwellian automated state, or as a bright, informed, humane and globally oriented democracy. Education represents the keystone in the evolution of our democratic societies, and as such, assumes a new significance. The recruitment and preparation of the educational leaders who will lead us into the 21st century must address the trends and issues that will either propell us successfully or hinder us dramatically in reaching our goal of educating the youth of today to be leaders of tomorrow in a peaceful and just world.

To translate purposes into educational action programs, school leaders must be prepared, they must be literate regarding the consequences of the microelectonic revolution, and the problems, issues, and opportunities this revolution is creating for schools. Our University preparation programs must change their programs to include courses that develop computer literacy, they must develop new perspectives for synthesizing knowledge and they must undertake new inquiry endeavors themselves.

We know that by the 21st century the microcomputer will have changed the political, economic and societal structures of societies around the world. It will definately change the educational

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structure. Most homes will have computers and access to large data bases of knowledge. Basic skills, and analyzing and synthesizing of information will be taught by the computer. Teachers will guide students in the skills necessary to access information. Even if this is not realized by the 21st century, schools will be dramatic restructured both internally and externally. Information systems will be decentralized and home-school relationships will have to experience changes for education to continue sucessfully. The administrative structure of the schools will become flatened, and decisions will be made by teams made up of administrators, teachers, parents and students. No longer will fields of study be independent and isolated, they will be interconnected by the microcomputer.

As new administrators are recruited and current administrators receive continued education to be prepared to lead the schools of the 21st century, microelectronic delivery of information takes on a new significance. We must begin to use such tools as satellite conferencing, and long distance learning to disseminate the new knowledge. Within districts, electronic mail and electronic conferencing will make information shared by principals and administration as easy as entering the message. There is a need to continually reeducate administrators and microelectronic technology is the key tool that must be used to do so.

If we contemplate the predicted changes in both our societies and profession by the 21st century, we can see the inherent need for regeneration of the field of educational administration and the magnitude of new learning administrators will have to undertake. It is time for the institutions of higher learning to begin creating programs that will truly prepare leaders for education's new environment. To prepare leaders that are computer literate, who can conceptualize programs necessary to prepare the youth of today to sucessfully function in the 21st centruy, and who will begin to operationalize their dreams today.

THE MEDC CIM CELL - LOCAL AREA NETWORK COMMUNICATIONS IN LINKED AUTOMATION

I.G. Warnock\~\~

ABSTRACT

In modern industry, adequate knowledge and experience in the areas of automation and computer aids is often essential to the competitive position and continued prosperity of a company in the marketplace. The highest level of automation is CIM - Computer Integrated Manufacture, and encompasses all aspects of a company's operation. This integration can only be achieved by appropriate communications between all constituent machines and computer systems, often using a Local Area Network (LAN). Due to the cost and size of such systems, there are few training facilities available for industrial or academic staff to experience the practicalities of linked automation or computer integration. The CIM project at MEDC aims to provide a minimal integtrated system for training and development purposes, with emphasis on inter-station communications and management software.

INTRODUCTION

At the Microelectronics Educational Development Centre (MEDC), there have been developments in several areas of CAD/CAM training, including the development of software packages on 3D CAD visualisation, NC Lathe simulation, and process 'mimic' simulation linked to external computer control. Although initially intended for internal use, these products have been successfully utilised throughout the post-school education sector.

COMPUTER INTEGRATION

Our interest in the application of computers and communications in automation led to the proposal for a Computer Integrated Manufacturing (CIM) system to be designed and implemented within MEDC. As discussed in Morgan (ref 1), CIM involves the integration of all elements and activities within a manufacturing system, and is much more than just an extension to CAD and automated manufacturing. These activities, along with many others, must be linked to a common manufacturing database, using a suitable communications system (often based on a local area network).

AIMS OF THE PROJECT

Our aim was to create a minimal system based on Local Area Network (LAN) communications, but possessing and demonstrating many of the facilities of a full scale CIM system. By this, we intended to address the problems of linking dissimilar machines and microcomputer systems, rather than established technology areas such as CAD and

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\~\~ Microelectronics Educational Development Centre

CNC. (Although early stages of the project would target these areas to allow inter-communication and the demonstration of file transfer and part production using CAM.)

This project would create a demonstration and training facility that encompasses as many elements of total integrated automation as possible, within a relatively tight budget. The project commenced in December 1986 and is expected to take approximately 2 years to complete.

Fig 1 Concept

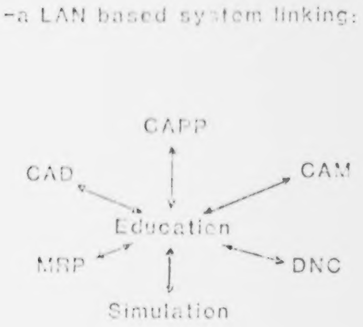
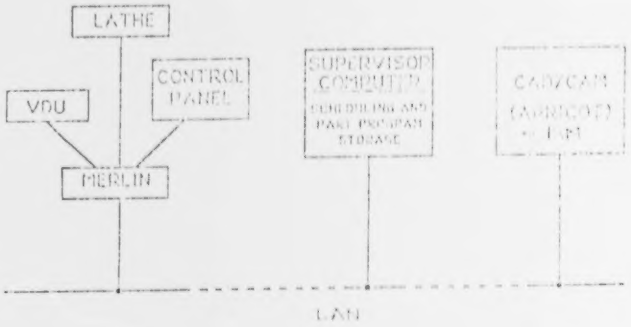

-a LAN based system linking:
CAPP
CAD
CAM
Education
MRP
DNC
Simulation

Fig 2 Stage i layout


LATHE
VDU
CONTROL PANEL
MERLIN
SUPERVISOR COMPUTER
SCHEDULING AND PART PROGRAM STORAGE
CAD/CAM
(APRICOT)
LAN

As shown in the diagram, the intended elements include:

CAD/CAM	computer aided design and manufacture
DNC	direct numerical control
CAPP	computer aided production planning
MRP	materials requirements planning

Simulation of part movements in the automated cell

Both individually, and as constituents of the CIM project, these areas were to be developed and used with an emphasis on the educational aspects of the technology. This was to be realised using several different approaches:

(i) staff involvement and self development
(ii) student projects on the various areas
(iii) use of the CIM project on short courses for academics and industrialists
(iv) publication and distribution of the project report by MEDC

SYSTEM CONFIGURATION

The system was to include:

a. A small-scale FMS, (Flexible Manufacturing System) consisting of:
cell controller (Merlin microcomputer)
robot (Atlas)
CNC Lathe (EMCO)

b. Stations for CAD, planning and scheduling, management information etc., using microcomputer-based software:

IBM AT with PGA (Professional Graphics Adapter) and Autocad CAD software + plotter.
IBM XT Network manager/supervisor with CAPP software + printer

c. A local area network to link all stations, allowing data to be transferred between relevant stations. For example, part program transfer to the CNC lathe; acquisition of plant performance data for processing and analysis using various software packages.

(The LAN was to conform with the International Standards Organisation (ISO) 7-layer model whenever possible.)

CHOICE OF LOCAL AREA NETWORK

The task of integrating a variety of intelligent devices into a complete system precludes the use of most propritary LANs, since these normally support only specific computers. An 'adaptable' network was required, that would provide an interface to the RS232 communications ports on the Merlin controller and Atlas robot. The Nine Tiles Multilink LAN was selected, supporting both IBM interface cards and RS232 mode connections to a twisted pair data highway.

STAGE 1 DEVELOPMENTS

Stage 1 of the System was completed as shown in fig 2. A significant amount of software design was necessary to integrate the different devices into the network. For the FMS area, each device required individual programming, building in the ability for program substitution to effect different part-production sequences.

The proposed robot (Atlas) was not included at this stage due to time constraints. It is to be added to the system as part of the stage 2 developments.

The completed first stage involved the following developments:

a. Post processor design for lathe.
b. Merlin communications software to link lathe and supervisory computer.
c. Configuration of multilink network, followed by development of networking software to link all required modes.

Facilities available to the user include:

(i) Part design using AUTOCAD on IBM AT
(ii) Insertion of tool path data onto the drawing
(iii) Creation of a DXF (Data Exchange Format) file for the part

(iv) Post processing of the part for EMCO lathe.

From here, the data file is stored in a file on the IBM AT hard disc. This file can then be uploaded into the network manager IBM XT over the network. From here, the data file is transferred via the Merlin Microcomputer to the EMCO Lathe. (The Merlin/lathe link is purely serial RS232, since the lathe does not have the capability to run networking software. However, having one or more machines being controlled over dedicated serial links is a valid strategy.)

This now formed a working demonstration of full CAD/CAM using a managed network environment, and has been successfully used on several short courses and seminars.

DEVELOPMENTS FOR STAGE 2

Approximately half way through the project, we have completed Stage 1 and are working on the remaining software applications to provide the integration of management, planning and production activities. This includes the in-house development of a materials requirements planning package (MRP) to run on the supervisory IBM XT. This application will be designed under a popular commercial database (DBASE 3+) and spreadsheet (Lotus 123) to allow its use and adaption by other institutions. The MRP software will provide planning and control of production in response to a marketing plan, using simulated demand and a 'factory' equipped with several simulated lathes in addition to the existing EMCO.

SIMULATION

There is increasing use of microcomputer-based simulations to aid in the planning and evaluation of various plant layouts and production plans, often with a graphics display of simulated operations within the plant. The MEDC CIM system is to be modelled using such a package (eg. Simfactory; SIMAN,;PC model), allowing users to experiment with production parameters and obtain direct feedback on the resulting effects.

FURTHER DEVELOPMENTS

We aim to complete Stage 2 later this year, followed by the production of a complete system 'package' for use by interested parties. The package will include all relevant MEDC software, listings and full documentation of the complete system. In addition, to further increase the appeal of the CIM system to other educational institutions, a low-cost cell controller is being designed to replace the present Merlin microcomputer.

REFERENCES

1. E. Morgan, Through MAP to CIM (Dept of Trade and Industry, 1986).

DISTANCE LEARNING BY COMPUTER COMMUNICATION

G.J. Makinson*

ABSTRACT

Software for computer enhanced learning can require, in many areas, such as Mathematics or Engineering, the computational power and storage capabilities of a fairly powerful and expensive mini-computer. To be effective it also requires sophisticated graphical displays. Multi-access can be obtained by linking up terminals using local area networks with all the equipment confined to a small area. As the cost of telecommunications diminishes, the viability of distributed access from distant sites over wide area networks becomes more of a reality. Examples now exist of interactive systems operating over a campus with terminals linked by campus rings or ethernet connections to central facilities. Software in use at the University of Kent is accessible across the campus via a Cambridge Ring network. The same software is accessible over JANET, the joint academic network serving universities, and can be run in interactive mode.

INTRODUCTION

Wide area networks operating at high speed provide facilities for file transfer and electronic mail. This makes possible the downloading of courseware for local operation. Computer communication over a distance already takes many different forms, the suitability of which varies for particular applications.

VIDEOTEX

It has proved possible to incorporate teletext frames of information within the transmission of television signals. This has meant that frames of encoded computer software can also be transmitted "over the air". Using a suitable hardware decoder the encoded information can be restored to the original computer program. Programs written in BASIC are transmitted in this manner by the BBC over CEEFAX and by ITV over ORACLE. Software transmission by this means is currently on a small scale since the number of frames available is severely limited. The process of transmission is slow but offers a cheap service covering vast areas. It can only be a delivery system and not a two-way interactive process.

TELESOFTWARE

The PSTN (public switching telephone network) has been used to provide a means of transmitting software from host computers down to suitable micros linked by a modem to the telephone network. PRESTEL, a viewdata service, has a number of information providers, e.g. Prestel Education and Micronet, which provide a library of software encoded in teletext frame format. The software is received by the terminal software in the

*Institute of Mathematics, University of Kent, Canterbury, Kent, CT2 7NF micro and converted into source code which may be BASIC or machine code for the particular micro. PRESTEL at the moment, operates at 1200/75 bits per second transmit/receive and hence some programs and long data files are compacted. This reduces the transmission time and hence the costs of transmission but necessitates a decompaction phase on the micro before the program can be run. Interactive communication with a host is possible over PRESTEL and via various Gateways to other hosts. The viewdata frame by frame communication with each frame 24 lines by 40 characters restricts the application of the service. Mosaic graphics can be used but not a dumb terminal display.

TTNS (The Times Network Service) offers the same viewdata format but also 80 column scrolling text terminal operation and hence permits a wider range of interactive applications. Graphical presentation is however restricted to the mosaic graphics of viewdata or dumb terminal display. Access can be at 1200 bits per second which makes the service suitable for electronic mail transmission.

FILE SERVER BASED LOCAL AREA NETWORKS

A highly successful arrangement for storing and running teaching programs is that offered by the use of a large capacity, hard disc, file server linked by a low speed network to a number of workstations. Examples of this configuration include BBC micros linked by an ECONET network, or RM Nimbus workstations linked by Nimbus Network. The sometimes severe limitation of such a system is that the teaching program has to be sufficiently small so that it can run on the workstation/standalone micro. If an interpreter or compiler has to fit in the memory alongside the program, then this imposes a further size restriction. The speed of operation of the workstation will also limit the response times and hence what applications are possible. Operations will also be governed by the operating system of the workstation. For instance concurrent processes may not be possible. Full graphical facilities will usually exist in such a set-up, but, unless the workstations are large and powerful, graphical software packages such as GKS will not be usable because of their size.

COMPUTER HOST LINKED BY A FAST NETWORK TO SMALL WORKSTATIONS

A fast network can link terminals over large distances. Kent has a Cambridge Ring network which links together all the computing facilities on the campus. This network is itself connected by Gateways to PSS (Packet Switchstream), IPSS and to JANET. Thus all the hosts at Kent are accessible from other university sites. File transfer and electronic mail facilities exist over these national networks. The fast connection makes possible the use of software from remote sites in an interactive mode for teaching purposes.

(a) Cross Compilation

One possibility is that of fast cross compilation on the host in place of compilation in the micro terminal. Such techniques have been employed across the campus ring at Kent between a Vax host in the Computer Laboratory and micros in the Digital Systems Laboratory. Downloading compiled code to disc on the micro can overcome some of the storage problems but the compiled program will still have to be of limited size to run in the small memory of the micro. The procedure for changing from using one teaching program to another may also be very cumbersome. Access to the software is only available to micros of the one type.

(b) Host Linked to Graphical Display Terminals

Fully interactive running over the Campus Ring of teaching software driving graphical display terminals has been operational at Kent for three years. In this configuration relatively small micros, emulating terminals, can provide a distributed graphical display system driven by software running in the host. Communication over a fast ring network permits the interactive computation and generation of graphical results with response times that are perfectly acceptable for teaching purposes. The fast network can be thought of in the wider context as the combination of a local area network, such as ETHERNET or a Cambridge Ring, communicating out through a GATEWAY on to a wide area network such as JANET (Joint Academic Network), then through a GATEWAY onto a LAN and hence to the host.

At Kent teaching software for Computational Mathematics is mounted on a High Level Hardware Orion running the UNIX operating system and this is accessed locally from terminals of various types distributed around the campus. The software has also been accessed interactively over JANET from a variety of terminals based at university sites around the country. Terminals at the universities of York, Cambridge and Strathclyde as well as at Imperial College and Brunel University have been used to study the teaching material. At all the sites the response times were not enlarged appreciably by any communication delays.

DEVICE INDEPENDENT OUTPUT

For successful distance learning it is desirable to have graphical output that can be displayed on many different graphical terminals. At Kent this is achieved by using DIGS, a graphical software package that produces graphical standard format files. By directing the output to alternative UNIX sinks in the form of device drivers it is possible to generate displays on VDU's or Tektronics or Sigma terminals or plotters such as Benson or Calcomp. BBC micros can display the graphical output using an inexpensive terminal ROM which permits the BBC graphics commands to be driven by the external host. With suitable software a screen dump facility can also be used to capture the screen image directly from the micro.

SECURITY OF SOFTWARE

Access from a distance gives opportunities for unauthorised use of the system by individuals and brings the risk of corruption of files. To combat this risk external users are only admitted to a restricted shell under a generic login which limits their access to a menu of programs. Exit from any program routes back to the original menu. This offers the choice of programs or the opportunity to leave the teaching session altogether.

MANAGEMENT OF COURSEWARE PROVISION

In the Kent system only one copy of the executable code is available to be called by the users. The source codes are not accessible and are kept in a directory organised under the UNIX file management system SCCS. When new versions of the sources are created the editing commands are stored so that the recreation of earlier versions can be carried out very simply if required. The system also prevents two people from editing the same source simultaneously. New package development is very much more efficient as the wasteful retention of multiple copies of outdated versions of a program is eliminated. Since a single master copy of the program is accessed by all users the updating of the software is a trivial operation once a new version has been tested and is to be brought into use.

Programs are written in C and the development process is helped enormously by the use of makefiles. These contain the details of the composition of the program and can be called to automatically assemble the program by compiling modules of source code and linking them with libraries, header files and existing object code. Only the source modules which have been modified are recompiled.

Dialogue in the teaching program is routed and translated into C code by an authoring system KAS (Kent Authoring System) so that updates to the dialogue and its routing structure can be achieved very easily.

Students are given the opportunity to type in comments from within the teaching packages and these comments are automatically appended to a file for that package. Notification of errors and suggestions for improvements are collected in this way.

Temporary files are created for output which may be printed. Statistical information on the use of the package is also recorded. The potential for "intelligent" guidance of an individual's progress through the package exists but is not yet incorporated.

A back up host is available in an emergency and software is archived in case of total machine failure.

An assessment of the cost effectiveness of the system is difficult to make as the network opens up the use of expensive facilities such as printing and plotting which are provided centrally. The benefits that accrue from using such a distributed teaching resource are considerable. Also notable is the sharing and hence the more intensive use of the expensive host computer. This supplies the computational power and extensive memory facilities which are not available on a single work station. When transmission costs become negligible, interactive distance learning will certainly be a viable proposition.

ISDN: IMPLICATIONS FOR HIGHER EDUCATION

Daniel E. Costello*

ABSTRACT

ISDN is a reality. At Southern Methodist University we are identifying existing and new applications that will benefit from the implementation of ISDN technology. Through a cooperative effort with Southwestern Bell Telephone and Siemens, a full scale research and trials program is now in process. The focus is on higher education with particular emphasis on the needs of faculty, students, and administrators. Some 200 ISDN lines have been made available for this purpose.

INTRODUCTION

The concept of ISDN (Integrated Digital Services Network) has been discussed in the telecommunications industry for over a decade. It is an all-digital network architecture that eliminates the need for costly separate voice and data networks. ISDN is based on a set of standards that are being developed by the International Telegraph and Telephone Consultative Committee and various other standard organizations. It provides voice, data, and video switching and transmission systems that all speak the same language, regardless of manufacturer or location.

ISDN has been described as a solution in search of a problem. It gives users a common transport mechanism for all communications. However, most users don't buy common transport mechanisms, they are interested in meeting functional needs through the use of basic services. This is why the "services" portion of ISDN has become the critical link.

To many, ISDN appears to be more manufacturer than market driven, more network vision than customer solution. The challenge is to turn this perception around. Through a close research partnership with the Edwin L. Cox School of Business at Southern Methodist University, Southwestern Bell Telephone and Siemens are gathering important information on faculty, students, and administrators needs and concerns that will enable them to package ISDN as a preferred network solution for higher education.

Our research consists of expert panels, focus groups, formal questionnaires, and live trials with individuals on and off campus. The 18 month trial portion will be used to demonstrate working ISDN situations. Our objectives are to

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identify by market segments (i.e. faculty, students, and administrators) existing applications that are improved by ISDN and applications that are difficult or costly to implement without ISDN capabilities.

WHY ISDN?

How is ISDN a more viable communications alternative than what is already available? At present on the SMU campus, a faculty member can use a local area network to access departmental information and yet require a dedicated terminal to access the university's mainframe computer. When at home this same faculty member can access information using a personal computer and a modem. Managing the diversity of equipment and user interfaces in this simple example is quite a challenge. If we consider that most university situations will include several different local area networks, mainframes, terminals, PC's, and application packages, the problem becomes almost impossible to manage.

Integrated voice and data, high speed access mechanisms, and mainframe connectivity devices, each attempt to solve part of the growing problem. Only ISDN overcomes the problem by providing a uniform method of transport and a single applications interface. The key is the focus on universal standards. ISDN is a network architecture which through standardization of user and network interfaces allows users access to multiple communication services.

The importance of a uniform approach to communications can not be stressed enough. The Basic Rate Interface, primarily for customer premise equipment, is composed of two B channels and one D channel, normally referred to as 2B + D. The bit rate of the D channel is 16 kb/s and 64 kb/s for each of the B channels. For machine-to-machine interconnections, such as between switches, a Primary Rate Interface corresponds to 1544 kb/s. The primary rate B channel interface structures are composed of 23 64 kb/s B channels and one 64 kb/s D channel. The European standard is 30 B + D or 2048 kb/s.

EXISTING IMPROVEMENTS?

What are some of these communication services and cost savings made possible through the use of standard interfaces? The flexible high speed bandwidth characteristics of ISDN allow users to communicate normally on the D channel packet capability but shift to the 64 kb/s B channel for high volume or priority transmissions. PC to PC file transfers provide an error free transmission at up to eight times faster than is currently done with 1200 bps dial modems.

In cases where 3270 terminals are emulated on the PC, the costs of coax cable, 3274 controllers, modems, and leased lines are avoided. The costs involved in moves and changes particularly for data circuits moves are as inexpensive as a telephone move. In addition to the functional consolidation of wiring, significant savings could be achieved by physical consolidation. Up to eight terminals, or two telephones and six terminals can be multi-dropped on a single ISDN basic rate loop. These are just a few of the existing applications and conditions that can be improved with ISDN.

NEW APPLICATIONS?

From our study to-date, there are a number of applications which draw upon a unique ISDN capability. These applications include:

* Registering for classes on the computer while talking with an advisor.

* Reviewing papers, assignments on the computer while talking with the instructor.

* Searching for library references on the computer while talking with a librarian.

* Ordering tickets for athletic events, concerts, and plays while reviewing a seating chart on the computer.

SHARED SPACE is the name given to the application that allows two people to share information on the PC's screen, and jointly control an existing PC application of interest to them both. A typical situation might be as follows: a student wants to review a spreadsheet assignment with his Accounting instructor. The student calls the instructor on the phone and wants to ask a question of him. The instructor agrees and they call the SHARED SPACE application which links their PC's together, using either the D-channel or a second B-channel. The student executes the command to display the spreadsheet, and both see the result on their screens. The student loads the data file, and again, both see it being loaded. Now both can execute spreadsheet commands, and both will see the results of those commands. The instructor's keystrokes are transmitted to the student's PC, where they are executed locally as though they came from the student's keyboard.

This application is a good example of voice/data integration. The two users are able to communicate much more effectively than they could with either voice or data alone. They are able to work as though they were sitting together in front of a single PC. Implementation of this concept without ISDN would involve the use of two telephone lines, one for the data transfer and one line for the voice call. ISDN eliminates the need for these lines and the associated modems.

CALL MANAGER is an application that has been identified as a way to increase the effectiveness of administrators. The CALL MANAGER associates a phone and the PC as if they were a single terminal. It provides: autodialing from a personal directory or from the application screen, identification of called and calling names including forwarded calls, logs of of incoming and outgoing calls, and selective line answer.

The CALL MANAGER is a resident application. User-to-user signaling is the ISDN mechanism that allows two devices to send information to each other via the signaling D-channel. The advantage of this approach for the integration of voice and data, is that it costs the user nothing in extra hardware, beyond what is needed to support the data applications. Additionally, much benefit can be derived from using a computer to control the voice network.

The MESSAGE DESK is an application that could provide an answering service for faculty. Faculty can forward their telephone to the MESSAGE DESK which is monitored by an attendant. When a call arrives for a faculty member, a disposition file is displayed automatically on the MESSAGE DESK screen based on the identification of the forwarding phone. From the disposition file, the attendant can inform the caller of the whereabouts of the faculty member. The attendant can then take a message from the caller which is saved by the MESSAGE DESK.

When messages are received, an indication is sent to the faculty member from the MESSAGE DESK to signal that messages are waiting. Messages may be received by the faculty member in one of several ways: from a PC, from a dumb terminal, or from a phone with a display feature. This application holds great promise for reducing the frustration of telephone tag.

CONCLUSION

This paper has not focused on all of the possible ISDN enhancements in higher education. FAX and slow scan video are other examples that can be integrated with voice and data to produce new instructional applications. Our research will identify applications, whether existing or new, that will benefit by ISDN capabilities. Those that show the most promise will be tested in trial situations. The future will be bound only by the limits of our imaginations ...

EXPERIENCES WITH AND RECOMMENDATIONS FOR A COURSE: ETHICAL ISSUES IN USE OF COMPUTERS

ROBERT R. RISER

ABSTRACT

The widespread use of the computer has raised new ethical issues and has changed the context in which many ethical issues arise. The major ethical issues involving the use of the computer must be identified and examined within the computer and information sciences curriculum in order to expose students to the ethical conflicts they may encounter in their professional careers and to provide an appropriate background from which to deal professionally and responsibly with such conflicts. Presented are experiences and recommendations based on teaching a course entitled "Ethical Issues in the Use of Computers".

INTRODUCTION

The use of the computer as a tool continues to increase in virtually all disciplines and areas of society. The computer has given rise to new ethical issues, has changed the context in which many ethical issues arise, and may also change perceptions of ethical issues. According to Deborah Johnson (ref 1) "in many cases the computer so transforms the context that ordinary concepts and acknowledged moral rules are pulled into a gray area."

As the computer becomes more and more pervasive, both as a personal tool and a professional tool, the need to identify and examine ethical issues involving the use of the computer and to provide a background from which students are able to deal professionally, responsibly, and knowledgeably with these ethical issues becomes more acute. This need should be addressed, within the curriculum, at all levels of computer and information science education, and should be considered an integral component of computer literacy. In particular, students must be made aware of the types of ethical conflicts and dilemmas that they are likely to encounter in their professional careers and of appropriate ethical approaches for dealing with such circumstances.

Interest in ethical issues in the use of computer has increased in the last decade, yet there remains relativity little research. Parker's work (ref 2) identified ethical conflicts in computer science and technology, and it attempted to develop general principles regarding the identified ethical issues. Johnson (ref 1) identified a central core of issues for which the computer poses significant ethical questions. Further investigation in those identified areas has been made by Johnson and Snapper (ref 3). The identified areas are liability for software malfunctions, professional ethics, computers and privacy, computers and power, and ownership of software. These three works are excellent resource materials on which to base a course concerning ethical issues involving the computer.

The author has taught such a course to graduate and undergraduate students from a variety of disciplines and has included material from that course in the undergraduate Software Engineering course as well as a computer literacy "service course." The observations and recommendations presented here are based on those experiences.

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COURSE OBJECTIVES

The specific course objectives are:

1. To discover and examine key ethical issues involving the use of computers;
2. To provide background, including an overview of ethical theory, to deal professionally, responsibly, and knowledgeably with these ethical issues;
3. To examine the role of the computer in ethical issues; i.e., to consider whether these issues are aggravated, transformed, created, or alleviated by the computer;
4. To consider whether or not the computer changes ethicality, i.e., whether or not the computer affects perceptions of ethical issues;
5. To understand the responsibilities that computer professionals have with respect to the ethical issues in the use of computers.

SYLLABUS

The following is an abbreviated syllabus for the course.

1. Introduction; review of course objectives, policies, requirements, prerequisites, and syllabus.
2. Introduction to ethical theory; review of ethical theories and need for ethical theories.
3. Ethical issue scenarios; review of Parker's methodology (ref 2); role of ethical issue scenarios in identifying and exploring issues throughout the course.
4. Issues of responsibility; liability for software malfunctions.
5. Computers and privacy; confidentiality; security; conflict between organizational needs for information and individual desires for privacy; increasing use of "cross matching" of data bases.
6. Software as property; ownership of software.
7. Professional ethics; professional codes and responsibilities; personal loyalties versus organizational loyalties.
8. Computers and power.
9. Ethical issues related to artificial intelligence and expert systems.
10. The computer and perceptions of ethical issues; is the computer an active or passive entity in ethical issues?

The last item in the syllabus is a current research interest of the author and is not covered in the references. It involves investigating whether or not the computer affects perceptions of ethical issues and/or acceptability of certain acts. For example, are comparable safeguards apt to be taken to protect private and/or sensitive computer files as would be taken to protect other information assets within an organization, and are we more likely to forgive (or be unaware of) inadequate safeguards in the former situation? Is the confidentiality of personal information collected for a specific purpose and subsequently used for another, more likely to be tolerated if the information is maintained in a computerized data base. Is unauthorized "browsing" of computer files more acceptable than similar browsing of non-computer files? Is plagiarism more likely in a "programming" course than in a writing course? And, for each of these questions, is the presence of the computer a factor in perceptions of ethicality?

USE OF ETHICAL ISSUE SCENARIOS

Parker (ref 2) used a scenario analysis methodology in his 1975 study (sponsored by Ethics and Values Studies of the National Science Foundation) of ethical conflicts in computer science and technology. The methodology utilized a series of short ethical issues scenarios, reviewed by a group of experts who then categorized behaviors described as unethical or not unethical. One such scenario is illustrated below.

> A scientist employed as a researcher in a university learned that two different kind of data on essentially the same subject pool were contained in two files stored in the university's computer. He believed that there would be significant scientific value in merging the files and reanalyzing the data. Although the subjects' informed consent had been obtained for the earlier studies (they were students who since graduated), their permission for this new use for the data had not been sought. Although the scientist was aware that it would have been desirable to seek permission of the subjects, he decided not to do so, because it would have added considerably to the cost of the study he was proposing. He thus asked one of the university's programmers to access the data, merge the files on the same subjects, and analyze the data as indicated. The programmer did as the scientist requested.

The acts to consider in the scenario are (1) the scientist's merging of the files without permission of the subjects and (2) the programmer performing the requested file merging.

The scenarios and the opinions of the reviewers as well as general principles derived from the study provide an invaluable classroom resource for discussions of ethical issues involving the use of computers. A workbook (ref 4) is available to facilitate such use. I used ethical issue scenarios, some developed by Parker and some developed myself, as focal points for illustrating and examining ethical issues. A particularly effective approach was to discuss a scenario prior to discussing the textbook's material related to similar issues. The scenarios seemed to provide students with a view of an issue with which they could relate, and subsequent coverage of related material became more meaningful and interesting.

SUGGESTED TEXTBOOKS AND ASSIGNMENTS/PROJECTS

Computer Ethics by Johnson (ref 1) is an excellent textbook for the course. It is short, interesting, and covers each of the major areas well, including a brief chapter on ethical theory. I suggest assigning appropriate readings in addition to the Johnson text. For convenience, I plan on using the book of selected readings, Ethical Issues in the Use of Computers, by Johnson and Snapper (ref 2), as a supplementary text. In addition, all of the books listed in the references are recommended as additional reading.

Several assignments/projects that have been used are briefly described below. All are designed to enhance student awareness of ethical issues. As previously discussed, the use of ethical issue scenarios greatly enhanced the class. The first two assignments described involve students writing their own scenarios.

1. Write an "ethical issue scenario", similar in format to those used in class, for each major issue discussed in class.
2. Write a set of ethical issue scenarios, similar in format to those used in class, for each major issue discussed in class. Each set is to consist of two scenarios; one that involves the computer and a second that is analogous to the first but does not involve the computer. Examples will be provided.
3. During the course, scan at least one newspaper daily and one news magazine weekly for items involving a "computer foul-up." Once you find an appropriate item, write a short description of the foul-up and an analysis of the cause. Speculate on how the foul-up could have been averted. Indicate and discuss whether there is an ethical issue involved.
4. Write a research paper entitled "Ethical Issues and Perceptions of Ethical Issues Related to the Use of Computers in ???????." Suggested words or phrases to complete the title are Education, Medicine, Business, Artificial Intelligence, Politics, Statistics, Computer Science, Communications, Robotics. The paper must include a review of literature, the relevant ethical issues that you have identified, and how those issues are being addressed. It must also include an analysis of interviews or a survey that you conducted with appropriate people related to the topic, including their perceptions of the ethical issues. Any survey instrument or interview questions used must be cleared with the instructor, and the university Institutional Review Board if appropriate.

CONCLUSIONS

It is increasingly important that an identification and examination of the ethical issues involving the use of computers be included in computer and information sciences curriculum and in any computer literacy program in order to make students aware of the ethical issues and to provide a background from which they can deal responsibly, professionally, and knowledgeably with such issues when they are encountered. Suitable textbooks and reference material exist for including the material as a stand-alone course or as a integral part of existing courses.

REFERENCES

1. D. G. Johnson, Computer Ethics (Prentice-Hall, Englewood Cliffs NJ, 1985)
2. D. B. Parker, Ethical Conflicts in Computer Science and Technology (AFIPS Press, Reston VA)
3. D. G. Johnson and J. W. Snapper, Ethical Issues in the Use of Computers (Wadsworth, Belmont CA, 1985)
4. D. B. Parker, Ethical Conflicts in Computer Science and Technology Workbook (AFIPS press, Reston VA)
5. D. Burnham, The Rise of the Computer State (Vintage Books, NY, 1984)
6. T. W. Bynum, Computer and Philosophy, Vol 16, No 4 (Basil Blackwell, Oxford and NY, 1985)

ETHICAL PRACTICES: A NECESSITY FOR THE INFORMATION AGE

Dr. Marlene Campbell

> The world is my country,
> all mankind are my brethren and
> to do good is my religion.
> Thomas Paine

ABSTRACT

This paper opens with very current examples of the tremendous hazards and complications that arise in our technological society because insiders and/or professionals choose to behave unethically. The primary purpose of the paper, however, is to provide academicians with both motivation and ideas for bringing ethics discussions into the classroom. It provides mechanisms for introducing these topics and discussing their importance for survival and progress in an information age.

INTRODUCTION

Sub-headlines in the December 18, 1987 issue of GOVERNMENT COMPUTER NEWS (page 55) read "Survey Shows Managers Doubt Honesty of DP Staff." In this article written by Marlene Brown and datelined LONDON, ADP personnel were rated as bigger risks to computer security than third parties, natural disasters or other employees.

On September 16, 1987, newspapers around the world carried the account of the West German hackers's infiltration of the NASA SPAN (Space Physics Applications Network). A perusal of the accounts that detail the events of the infiltration reveal evidence that intelligent and educated individuals used their technical expertise in a ploy that should have been reserved for hooligans.

On July 20, 1987, Bill Beutel (sitting in for Paul Harvey on Midday News and Comment) reported that banks lost $1.1 billion to crime and fraud in 1986. Of this amount, up 1/3 since 1985, 72% was attributed to insiders.

These are but three of many such reports printed and aired in the past decade. Because of such reports and the glorification of the perpetrators, we who work with future computer professionals and other future professional and management types must, somehow, instill in the students the necessity for operating in an ethical manner in all situations. We must, indeed, shoulder this responsibility if a reversal of such practices is ever to occur.

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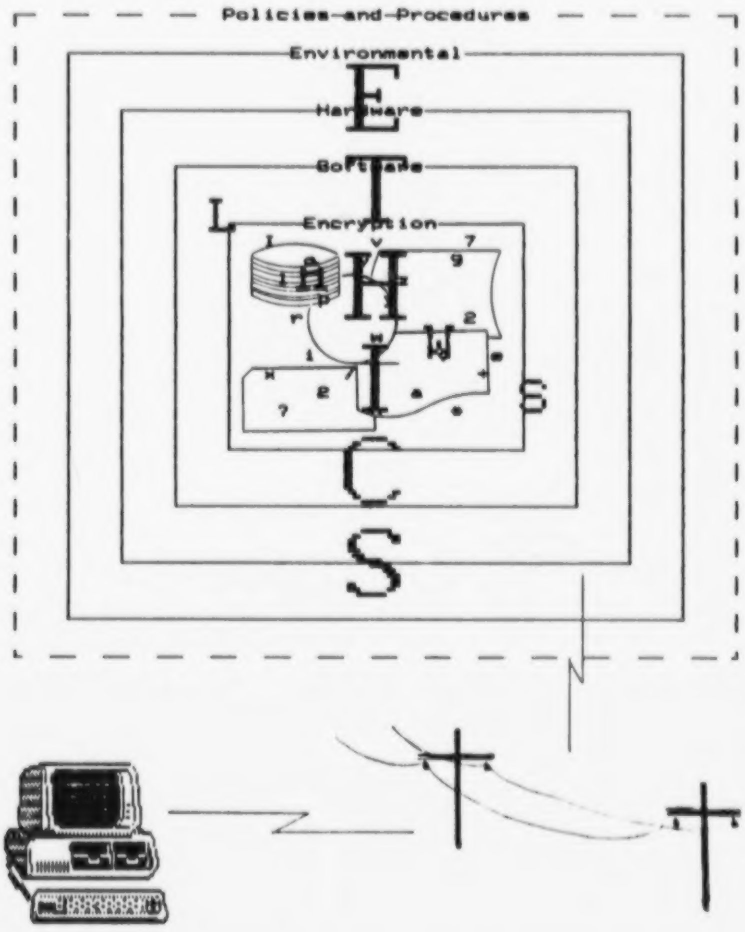
BACKGROUND

Privacy is a guaranteed right of the American citizen and a desire of all people everywhere. Security is an obligation of anyone who has something of value, tangible or otherwise, that needs to be protected. Where computers are involved, however, we have tended to view both of these notions in a different light than with the traditional concepts of privacy and security. Such incongruencies must be eliminated.

Figure 1 illustrates the five layers of computer security that can be initiated through management decisions to provide a secure system. In the United States, these layers are covered again by laws. Forty-seven of the fifty states have enacted computer crimes legislation, and many have privacy laws which predate the computer crimes laws. National legislation regarding computer crime, privacy, and ethics has been enacted and amended over the past decade.

Overlaying this entire security system is ethics, that collection of moral principles and rules of conduct recognized in a particular culture or class within a culture that tempers the behavior of citizens of that culture or class. Since each of the layers of security is devised by man, each can, in turn, be defeated by man if he so chooses. Laws, also, can be broken. Their existence does not guarantee that all who choose to break them will be punished or even that the law will be stringently enforced.

Figure 1: LAYERS OF COMPUTER SECURITY



It is obvious, then, that ethical practices are the hope of the future for continued progress and prosperity. Both the Association for Computing Machinery (ACM) and the Data Processing Management Association (DPMA) have adopted specific Codes of Ethics for their membership, and these codes should be familiar to both practitioners and students. The ACM code begins:

> Recognition of Professional Status by the public depends not only on skill and dedication but also on adherence to a recognized Code of Professional Conduct.

DPMA begins its Code of Ethics with a statement of obligation to management, to fellow members, to society, to employer, and to country. The Standards of Conduct specifies the responsibilities of each of these obligations. Both of the documents are available from the sponsoring organizations and should be provided to students who plan to become computer professionals whether they are members of these organizations or not.

ACTION AND REACTION

The first level of Computer security is the development and implementation of policies and procedures that establish the ground rules. That these ground rules must be followed is a matter of professional ethics. Although ethical behavior patterns begin long before formal education, it is not too late to modify some of these behaviors much later in life; and there is no better place to initiate changes than in the classroom that is preparing young people for responsible citizenship in a highly technological society.

Perusal of recent and not so recent literature will reveal statements such as:

> If you want to steal and not get caught, use a computer and steal a lot.
>
> Seventy percent of computer crime is directly traced to insiders.

Is it reasonable for academicians working with future workers, managers, and professionals to ignore these ideas? Or, is it more reasonable to discuss them and further discuss the responsibilities that go with knowledge.

Virtually every college textbook for use in introductory information systems courses has one or more chapters devoted to social issues and implications. Most have at least a brief discussion relating to ethics. Texts for introductory computer science courses contain chapters on file processing and occasionally make reference to data security and integrity. Database and file processing courses, systems analysis and design, and others have very good entry points for in-depth discussions relating to ethics and the professional or manager.

Introducing the topic at a reasonable point in the overall course plan yields an acceptance of the relevance of such discussion in the classroom. It is then up to the instructor to capitalize on that moment. But, in order to capitalize, one must be prepared. I believe the very best preparation is reading. Read newspapers. Read magazines. Read journals. Read books. Clip and save relevant articles when possible; and when not, make notes. Send students to the library to do the same and read what they find and share with the class. Talk to colleagues about a concern for ethical decay and discuss issues with them. An openness about such concern generates a communications channel that will provide more and more information relating to the issues and an always current collection of "for instances" to share with students.

The Thomas Paine quotation at the beginning of this paper is quite provocative and can serve as a springboard for a lively discussion of ethics. The following quotations from Bloombecker (ref 1) might also prove motivational:

> ... Nothing, I suggest, gives me as much hope that things can be made better than making things better. I consider myself fortunate to know that through working at computer ethics as a response to the advance of computer technology I have been able to make things better.

Beware! If an instructor discusses ethical practices with students, he/she must be comfortable with his/her personal convictions and practices. Students will ask very pointed and personal questions, and the instructor must field them and respond to them openly and honestly.

CONCLUSION

Since the beginning of time when God instructed Adam and Eve, mankind has received instructions both spoken and written, as to the expectations of ethical behavior. Since the beginning of time when Eve chose to eat the apple and share it with Adam, mankind was exhibited a reluctance to adhere to those instructions. Is it futile, then, to expend time and resources trying to establish expectations and attempting to implement procedures for effecting compliance with those expectations? I think not! In fact, I agree with the philosophy implied by the title of Blumenthal's (ref 2) book, MORAL RSPONSIBILITY: MANKIND'S GREATEST NEED.

Indeed, moral responsibility is a very great need. As man conquers new frontiers this responsibility mushrooms, and academicians must accept the responsibility for influencing young minds to the awareness of their emerging responsibilities both to themselves and to their fellow man.

1. J. J. Bloombecker, Comps & Soc V16, n4, p3 (1987)
2. A. Blumenthal, MORAL RESPONSIBILITY: MANKIND'S GREATEST NEED (Rayline, Santa Anna, CA 1975)

TELECOMMUNICATIONS INITIATIVES ON AN INTERNATIONAL SCALE: BUILDING THE GLOBAL VILLAGE

Betty Collis*, Erich Neuwirth°.

ABSTRACT

The potential of telecommunications as an educational tool is an object of considerable interest and activity throughout the world. Many individual telecommunications projects are occurring, often involving international interaction among students and teachers. Some of these projects focus on communication and functional writing, others on the joint development of data bases of information relating to natural science or social science topics, and others involve the accessing of on-line commercial data bases. In this presentation, we develop a plan for the synthesis of these many experiences and discuss the potential of an international professional association (ICCE) as an agent for the evaluation and dissemination of information about educational applications of telecommunications.

INTRODUCTION

Occasionally an idea for educational innovation appears to emerge spontaneously in many different places throughout the world. The potential of telecommunications as an instructional tool is such an idea. Currently there are many educational telecommunications projects, many international in scope and each representing a combination of belief in the potential of the enterprise and a considerable expenditure of time and effort in developing infrastructure and maintaining technical support. Unfortunately, many of these projects seem to share other characteristics as well, among them:

1. a lack of instructional integration and relevance, so that the telecommunications usage remains at the stage of being a pilot project for an adjunct to instruction rather than an essential component of that instruction

2. little or no accompanying, instruction-referenced teacher support materials, either for teachers in the specific telecommunications project or for other teachers more generally to access and share

In addition, from an overview position, there is also a conspicuous lack of:

3. communication and information exchange between and about existing projects

4. synthesized evaluation data about existing projects

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5. a recognized agency to act as a focal point for information about existing projects, including methodological strategies and evaluation data

6. evidence for substantial gains in educational productivity or achievement associated with telecommunications experiences

7. any type of common protocol for user interface with existing telecommunications projects.

RESPONSE: THE ICCE TELECOMMUNICATIONS INITIATIVE

In short, there is a need for coordination and focus, from a worldwide perspective, with respect to projects relating to the educational application of telecommunications. The International Council for Computers in Education (ICCE) is in a position through its worldwide network of individuals involved in policy and planning with respect to technology in education as well as with respect to its strong teacher base and teacher training orientation to become this sort of focal point and to serve as a catalyst for coordinated growth in a variety of areas associated with educational telecommunications. In particular, ICCE proposes a broad and ongoing telecommunications initiative comprised of three strands: publication and print materials, short-term projects, and long-term applications. Current planning for this initiative involves the following activities in these three strands:

PUBLICATIONS AND PRINT INITIATIVES

ICCE is well positioned to produce and disseminate print materials for teacher use through its flagship journal, The Computing Teacher, and through its publications arm which currently produces and distributes over 40 monographs, resource booklets, and other similar teacher support materials. We suggest the following specific additions, all relating to educational telecommunications:

1. A monthly column in The Computing Teacher focusing on instructional uses of telecommunications

2. The development of a SIG (Special Interest Group) newsletter focused on educational telecommunications with particular interest in distance education, international telecommunications projects, and adult-oriented educational telecommunications projects as well as school-based projects

3. The development and maintenance of a data base of information about current educational telecommunications projects and the dissemination of information from this data base to interested members of the instructional community

4. The eventual publication of a substantial book on educational applications of telecommunications. Such a book should reflect an international perspective and include methodological and theoretical considerations relevant to classroom teachers and to project leaders and trainers working outside of the school framework

SHORT-TERM PROJECTS

1. Develop telecommunications strands at conferences ICCE supports or cosponsors.

2. Develop and pilot training models for instructional usage of telecommunications at at least three levels:

- school teachers
- instructors involved in vocational training and adult education
- instructors in distance education and teacher and project leader training for developing countries

These models would be focused on the training of trainers and teacher educators to better convey technical and pedagogical strategies to the clients with whom they work.

3. Organize and conduct a one-week symposium, planned for Israel in August 1989, on the educational applications of telecommunications. Part of this meeting would involve general dissemination of information and usage strategies; otherwise the meeting will focus on teacher and project leader working sessions in which participants will generate plans for telecommunications usage in their own workplaces.

4. Provide support for teachers, trainers, and project leaders who have attended the symposium described in Point 3 above to use telecommunications in their teaching situations and to cooperate in the evaluation of this usage. This activity is intended to occur from September 1989 through April 1990; reports of the project and its evaluation are planned to be presented at the IFIP World Conference in Sydney in August 1990.

LONG-TERM APPLICATIONS

1. Support new telecommunications projects that use existing networks to investigate and implement distance learning models for both children and adult learners.

2. Use existing networks to implement global access to training courses and/or university-level instruction for teachers involved with the use of technology in education.

3. Develop Resource Centres whose task would be to serve as central collection, dissemination, and evaluation sites for information relating to educational telecommunications activity worldwide. These centres could become leaders in the development of support materials to use in teacher training as well as in instructional settings, and also work to facilitate communication between existing projects, both on-line and through other avenues of information exchange.

CONCLUSION

ICCE proposes to provide professional and experienced educational leadership in these activities. It can supply an already well developed network of information exchange among its nearly 13,000 teacher-members as well as draw on the expertise of the many professionals with international experience who are already associated with the group. Clearly, however, even broader international support for the various components of this activity is needed. During 1988, the ICCE Telecommunications Steering Committee plans to initiate or continue to promote action with respect to each of these projects. We call on educational leaders from Europe and outside of Europe who share our interest in promoting the meaningful use of telecommunications in education to join with us in our planning. The potential is clear; it is the development of effective strategies for harnessing this potential which offers educators a major challenge.

MEASURING APTITUDE AND ATTAINMENT IN A MACHINE-BASED LEARNING ENVIRONMENT

Horace Mitchell*

A. ABSTRACT

In parallel with an established conventional training facility, the Alfred Marks company has set up a number of "High Street Learning Centres" where all training is machine-based (Interactive Video Instruction and Computer-based Training). From a commercial standpoint (post-training job performance) and from the subjective response of students, the Learning Centres are very successful, and no detailed evaluation of the learning process and student performance is commercially necessary. However, in collaboration with the UK Manpower Services Commission, the company now seeks to apply technology to a wide range of diagnostic and measurement activities, including initial assesment of students; matching to prospective jobs; training need diagnosis and curriculum planning; measures of attainment. The selected approach is described, with early experience and development plans.

B. THE LEARNING CENTRES: OBJECTIVES, STUDENTS PROFILE AND LEARNING GOALS

1. Commercial rationale for the Learning Centres

The Alfred Marks company is a temporary staff and employment agency, best known in the office field, but also active in catering and in a number of industrial sectors.

Since 1981, Alfred Marks has operated a specialist in-house training centre, with the primary commercial aim of improving the competitiveness of its mainstream business by equipping temporary and permanent staff to cope with rapidly changing office technology - initially word processing for typists, subsequently office systems for secretaries and others, and latterly microcomputer applications for managers and professionals.

Demand for this training is at a high and rising level, while supply is constrained by the shortage of existing skilled trainers: difficulty and high cost in recruiting new staff who have the necessary aptitudes: and a long learning curve for new trainers. The Alfred Marks Learning Centres started as a method of solving these training supply problems, and has also proved more cost-effective than conventional methods, saving student time through more rapid progress: reducing the need for skilled trainers: and freeing the most experienced staff for development, evaluation and counselling work.

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2. Profile of the student population

A very varied student population uses the Learning Centres, including: unemployed or unwaged persons seeking permanent or temporary placement: managers and professionals seeking to increase or upgrade their skills: client staff sent for training on specific systems: existing temporary staff acquiring additional skills: and Alfred Marks permanent in-house managers and staff.

3. Learning goals and methods

With the exception of the Alfred Marks in-house staff (a small minority) the students are almost all motivated by specific employment prospects - for the unemployed/unwaged, the prospect of obtaining a job: for the employed, the prospect of increased pay. The nature of Alfred Marks' business means they are able to virtually guarantee the reward of employment or increased earnings for those who successfully complete a recommended curriculum.

Within the Centres, learning methods are entirely computer-based, with an approximately equal mix of CBT and IVI courseware. All learning stations are equipped for both CBT and IVI. Tutor support is by a Centre Manager/Facilitator, with specialist backup from the Alfred Marks Training and Support Centre if required.

C. ASSESSMENT REQUIREMENTS: BASIC COMMERCIAL NEEDS

The overriding interest of Alfred Marks is not at the intrinsic level of "what has the student learned?", but at the "consequence" level: how has the learning affected employability and earning power? If the student completes a course, but fails to get and keep an appropriate job, or to perform satisfactorily at a higher earning rate, the course has failed. Currently (after 5 months experience and over two hundred students), the success rate measured in these terms is 100%. Working a shift system on five days a week and with regular weekend working, the initial Learning Centre (at London's Piccadilly Circus) is thought to be Europe's most intensively used machine-based training facility.

D. ASSESSMENT REQUIREMENTS: THE NEED FOR MORE DETAILED INFORMATION

With a 100% success rate, it might be thought that the company would not need to delve more deeply into measurement of the learning process. However, Alfred Marks now sees the Learning Centres as a critical element in the medium term growth and success of its primary business, and as potentially self-funding or even profitable through the attraction of fee-paying "external" students alongside the primary audience. The present three centres are being extended to form a "core" chain of at least 12 main sites in primary urban arease, supplemented by additional "satellite" mini-centres.

Accordingly, the company now requires more detailed assessment of the student and measurment of the learning process for the following main reasons:

1. Internal comparison across a range of Centres
2. Comparative evaluations of differing learning technologies and courseware
3. NCVQ: need for a consistent and externally accepted method for assessment of attainment
4. Quality and consistency of aptitude assessment and curriculum guidance
5. Effectiveness and reliability in job-matching diagnostic
6. Overall quality control and development

Note: currently, items 4 and 5 are carried out by Alfred Marks branch managers and counsellors with a high degree of success, but there is thought to be scope for further improvement in results and costs through computer support to these functions.

E. SPECIFICATION FOR AN ASSESSMENT SYSTEM

This will be the main topic reviewed in the conference discussion. Within the scope allowed for this written paper, only the highlights are presented here, with an explanatory note where necessary.

1. General characteristics of the required system

   a) "Walk-up" ease of use
   b) Brevity vs depth - must be adaptable enough to select between the "short, sharp" diagnostic required by a knowledgeable student versus the in-depth "interview" for a job-seeker.
   c) Technical environment (hardware/software) - must fit with IBM PC/PS family and existing branch office systems.
   d) Robustness and maintainability

   e) Administration by "unqualified" personnel (for psychometrics)
   f) "In-house" maintenance of knowledge bases - must be accessible to in-house training "expert" without involving systems specialist
   g) Automated pooling/polling of data
   h) Security and access control; Data Protection Act compliance
   i) Selective transfer of data to other systems
   j) Available as a generally-used commercial product - not "made to measure" with Alfred Marks as sole user
   k) Provenance and stability of vendor
   l) Purchase, deployment and enhancement costs
   m) Enhancement plans and competence of vendor

2. Functions - initial diagnostic "front end"

   a) Assess student's purpose
   b) Establish student's general level of cognitive ability
   c) Seek and acquire student's self-assessment of relevant data (biodata)
   d) Administer appropriate tests
   e) Propose job mapping
   f) Propose learning goal(s)
   g) Propose curriculum

3. Functions - progress monitoring

   a) Seek and acquire student attendance data
   b) Seek and acquire curriculum progress data
   c) Seek and collate attainment data acquired by courseware within the learning activity

4. Functions - post-learning assessment

   a) Administer tests of attainment
   b) Diagnose updated mapping to learning goal(s)
   c) Propose further curriculum or placement action

5. Functions - post-learning follow-through tracking

   a) Acquire feed-back data on a scheduled basis
   b) Maintain student profile for future goal and curriculum diagnosis

F. Characteristics of the selected technology
G. Early experience and conclusions
H. Development plans and expectations

The chosen system combines expert systems, relational database, psychometric testing in a flexible "shell". The system and our early experience in its use will be described in the conference session. An additional short paper summarising these aspects will be available at the Conference.

Integrating Instructional Objectives, Strategies & Technologies: Opportunities for Concurrent Second Language Development and Subject Matter Mastery in a CAI, Cooperative Learning Setting

R. A. DeVillar

ABSTRACT

Instructional programs in the U.S., whether regular, bilingual, or ESL, have not resulted in significant second language or general academic gains for the majority of non- and limited-English speaking students in grades k-12. Instructional strategies using cooperative learning and computer-assisted instruction increase opportunities for content-related talk in the second language. In peer groupings, a speaker's quantity and quality of talk in the first and second languages will differ, in part, according to the second language proficiency of the interlocutor and the computer task for which the speaker is responsible.

INTRODUCTION

English language proficiency and academic achievement are concepts that educators and researchers, as well as the general public, tend to interrelate (ref 1). The fundamental notion is that to succeed in school a student must at least know how to understand and speak, and later, read and write, the language of the classroom. English language proficiency does not guarantee academic success, but its absence suggests poor academic achievement. Thus, among educators, as well as others affecting educational practices and policies, the very foundation of academic success is, to a great degree, intuitively based upon English language proficiency.

There are millions of school-age children, however, who are designated as lacking sufficient English language proficiency to be able to profit from instruction given solely in English (ref 2). Over the years, especially the past twenty, the educational needs of limited- and non-English proficient children have been addressed by school programs in different manners and to varying degrees. Three types of instructional setting, however, may be currently identified as major strategies of pedagogical intervention: (1) regular classroom setting, where the student receives instruction in all content areas in the second language (L2); (2) second language program setting, where the student's exposure to content area instruction in the L2 is supplemented by formal L2 learning instruction usually, although not necessarily, external to the regular classroom setting; and (3) bilingual classroom setting, where the student's content area instruction is given, to varying degrees, in the student's native language (L1) and the L2. These intervention programs are neither mutually exclusive nor are they monolithic (ref 3). Their primary goal, however, is identical: to convert non- and limited-English proficient (NEP and LEP, respectively) students to fluent English proficient (FEP) students in as short a time period possible to significantly enhance the probability of their academic success within the U.S. school system.

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Irrespective of the type of instructional setting, however, the general outcome of these programs has not significantly improved the academic achievement or the English language proficiency of language minority children. This has been particularly conspicuous in those whose first language is Spanish, where drop-out rates and retention rates have been higher, and the degree of aspirations and expectations generally lower, than any other minority group (refs 4, 5). In summary, schools have experienced general and long-term failure in serving as a setting within which Hispanic and other language minority students learn English or significantly improve their education. Even within the special conditions of bilingual education and second language programs, generally inadequate research methods, especially non-randomization, have necessarily made suspect the validity of the vast majority of reported results (ref 6). Also, bilingual programs generally rely on federal funding where state and local funding are inconsistent. Thus, their educational reach is limited, regardless of their utility value, to between 7 to 10 percent of the NEP/LEP population (ref 2). Regular classroom instruction, then, reremains the predominant instructional strategy for most NEP/ LEP students.

Regardless of the relative extension of each of the three major types of pedagogical intervention, a fundamental question arises with respect to the opportunities that each provides its students for learning English as a second language. Research indicates the extent to which these three types of pedagogical intervention differ in what they offer the student in English language development opportunities and, by intuitive extension, academic achievement opportunities. In the regular classroom setting, teachers dominate talk. Within this setting, the amount of talk allocated per student would only average between 20 to 30 seconds, at best, per class period. Talk by students, furthermore, is predictable, consisting largely of short-answer responses to mainly factual questions for which the teacher already has the answer (ref 7). Even within a bilingual education setting, conditions for English language acquisition can be minimal. Milk (ref 8) identifies two reasons why: (1) classroom grouping strategies keep children of the same proficiency level together and thereby encourage the use of the dominant (non-English) language, as well as thwart exposure to, and meaningful communication in, English; and (2) teachers assume that English acquisition will occur naturally within the bilingual classroom setting and therefore do not see a role for consciously planning its use and development. Finally, learning a second language through special classroom instruction has seldom been a successful enterprise. English as a Second Language (ESL) classes have been found to offer very little opportunity for English language practice by the learner or to hear English used for communicative purposes (ref 9). Indications are that English language instruction on a formal basis, by itself, will not significantly improve the English language proficiency of language minority children. In a very real sense, then, all three pedagogical interventions present similar obstacles to successful acquisition of English. Thus, the type of educational program, by itself or in combination with one another, appears insufficient to predict or encourage achievement-oriented English language acquisition and development among language minority students. Further, English language outcomes (and subsequent achievement in content areas) may depend more on the specific **instructional strategies** adopted in an educational program and their creative manipulation by the teacher.

RESEARCH RESULTS

Relatively recent research from the three areas of second language acquisition, cooperative learning, and computer-assisted instruction (CAI) have independently identified particular socio-psychological and contextual factors which appear to favorably influence language use and academic achievement within the instructional setting. The implication from this collective research challenge traditional models of instruction based mainly on whole-class instruction, competition-based learning, and teacher-centered instruction. The respective alternatives which are offered as complementary strategies to the above include **small-group instruction, cooperative-based learning**, and **peer-centered learning**. Moreover, these alternatives, singly or in combination with the others, have been further enhanced with increasing regularity by computer-assisted instruction offering students enrichment, rather than solely remedial (i.e., drill & practice), learning experiences.

The rationale for integrating alternative instructional practices with the more traditional ones is simple: the traditional instructional practices do not allow for qualitatively or quantitatively meaningful student verbal interaction within the class period. The alternative instructional practices, on the other hand, generally encourage talk and, by design or nature, produce it. Both cooperative learning (ref 10) and computer-assisted instructional (ref 11) settings have been found to facilitate talk among students in general. Moreover, when these two instructional alternatives were combined, clear cognitive advantages over students working independently at the computer resulted (ref 12). More recent research (ref 13) has provided evidence that talk in English among non-native English-speaking students, is also enhanced within a bilingual, cooperative-type, CAI learning setting. DeVillar studied the verbal output in terms of quantity and quality of native and non-native speakers of English in matched (i.e., same English language proficiency level) and mixed (i.e., different English language proficiency levels) dyads within a sixth grade, bilingual (Spanish-English), classroom. Quantity referred to the number of English words produced by each individual speaker within a dyad. Quality was measured, in part, in terms of the respective number and mean length of three types of utterances: simple sentences, complex sentences, and sentence fragments. Each member of a dyad had a specific task: responsibility for all keyboard operations or reading of screen text. Responsibilities were interchanged at equal intervals during each observation session.

In mixed dyads, the presence of a native English speaker consistently enhanced the quantity (e.g., English word count) or quality (e.g., mean utterance length) of English spoken by the non-native English speaking partners. The role of the native English speaker was especially prominent when paired with the NEP speaker. Dyads comprised of non-native English speakers at the FEP and LEP levels spoke to each other for all practical purposes in English, within both matched and mixed dyads. Virtually all the Spanish produced was within non-native English speaking dyads involving at least one NEP speaker. Thus, grouping by English language proficiency, coupled with cooperative and enrichment-type CAI strategies, had clear differential effects on the amount and quality of

English produced by non-native English speakers. Moreover, all speakers other than the NEP speakers tended to produce more English at the keyboard task than at the screen task.

In conclusion, it is necessary to look beyond the label of a particular educational program and, instead, analyze the opportunities that it presents language minority students for acquiring and developing English within a communicatively meaningful context. At the same time, it must remain clear that content learning in a variety of subjects is simultaneously required of, and to various degrees transpiring among, language minority students, irrespective of their designated English language proficiency levels. Thus, talking in the second language is but one of two pressing educational objectives. Non-native English speakers working together may facilitate initial content learning through the use of their first language, exclusively or in combination with the second language (i.e., code-switching). Grouping strategies, cooperative learning techniques, and CAI instruction, if designed, integrated, applied and evaluated against the dual criteria of English language acquisition and content area achievement, may provide non- and limited-English students a meaningful learning context for achieving both.

REFERENCES

1. J G Graham, TESOL QRTLY, 21(3), 505-521 (1987)
2. C B Stein, Sink or Swim, The Politics of Bilingual Education (Praeger Publishers, NY, 1986)
3. A G Ramirez, Bilingualism Through Schooling (SUNY Press, Albany, NY, 1985)
4. E Hernandez-Chavez, in Studies on Immersion Education, (California State Dept. of Education, Sacramento, 1984), pp 144-183
5. C L Walker & S J Rakow, Hispanic Journal of Behav Sci, 7(3), 225-245 (1985)
6. A C Willig, Educational Research, 55(3), 269-317 (1985)
7. H Mehan, Learning Lessons (Harvard Univ Press, Cambridge, MA, 1979)
8. R Milk, Varieties in Language Use Patterns Across Different Group Settings in Two Bilingual Second Grade Classrooms (unpublish phd diss, Stanford Univ, CA, 1980)
9. M H Long & C Sato, in H Seliger & M H Long, Classroom Oriented Research in Language Acquisition (Newbury House Publishers, Rowley, MA,1983), pp 268-285
10. D W Johnson, R T Johnson, E Holubec Johnson, & P Roy, Circles of Learning (Assoc for Supervision & Curr Developm't, Alexandria, VA, 1984)
11. H J Becker, J of Computers in Math & Sci Teaching, iv(2), 42-49 (1984/85)
12. D W Johnson, R T Johnson, & M Stanne, J of Ed Psy, 77(6), 668-677 (1985)
13. R A DeVillar, Variation in the Language Use of Peer Dyads within a Bilingual, Cooperative, CAI Setting (unpublish phd diss, Stanford Univ, CA, 1987)

THE USE OF VOICE OUTPUT WITH EDUCATIONAL SOFTWARE

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Abstract

Voice output adds a whole new dimension to a student's interaction with a microcomputer. Although very little research has been done to determine the assets and liabilities of the addition of speech to educational software, it has become an integral part of numerous popular programs for special education and early reading and language acquisition software. Speech can be added to almost any educational program using methods which vary from robotic-type voice to completely natural sounding speech. Each approach has its limitations and trade-offs; consequently, no single method of speech processing has set a standard. This paper will examine some of the popular techniques for generating computer speech, briefly review some of the research pertaining to voice technology in education, highlight some of the popular applications, and discuss ways that computer speech might evolve in the future.

Introduction

The use of computer generated voice in conjunction with educational software in the United States is a relatively new phenomenon. The technology has been available for classroom use for over ten years, yet it has only recently become widely used. With the exception of IBM's Writing to Read , most of the talking software produced for the education market prior to 1986 had a special education focus. However, in the past two years the majority of the speech-based instructional programs that have been introduced are aimed at the general education market as well.

Voice output can be delivered through a microcomputer in a variety of ways. This variation in the manner in which voice is added to educational software has contributed to a number of misconceptions about voice technology. Unfortunately, these misconceptions confuse many developers and consumers regarding the potential utility of "talking" software.

The Technology

The quality of computer voice output is primarily a factor of the amount of computer memory used to process the speech. The three most common ways of adding speech to educational software are text-to-speech, stored natual voice synthesized by linear predictive coding, and compressed digitized human speech.

The highest quality computer speech is derived from human voice that is recorded and then digitized. The digitized speech signals may also be compressed (by specialized software or by the digitizing hardware) and then stored in the computer's memory. To play it back, the signals are decompressed, converted back to an analog signal, and then output through a speaker. The amount of memory used for this process is dependent on the amount of compression : the less the speech data are compressed, the higher the speech quality. Typically, one second of digitized speech requires approximately 4,000 bytes of memory.

The two most popular techniques for digitized speech compression in educational software are CVSD (continually variable slope delta modulation) and ADPCM (adaptive differential pulse code modulation). As a rule, both of these methods use specialized hardware for both recording and playback . Basic hardware for outputting uncompressed voice data (a digital to analog converter [DAC] and amplifier) is now standard on some microcomputers such as

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Apple's Macintosh and IIGS. Although compression techniques have been developed to use the more rudimentary sound hardware found on other micros, most computers require "add-on" circuitry to process any voice data.

Unfortunately, if a mass storage device is not used, the amount of digitized voice that can be stored and processed by a microcomputer is very limited. Most educational software is graphics intensive, which also requires substantial memory. Consequently, there is very little memory left for voice data. As the use of mass storage devices becomes more prevalent, and as core memory in microcomputers expands, adding high quality voice to educational programs will become more practical.

At present, the most popular means of adding voice to software involves the linear predictive coding (LPC) technique of speech processing. LPC is extremely memory efficient: high quality voice can be produced using approximately 175 bytes per second of speech. With this method, human voice is recorded, digitized, and broken into frames (analysis windows) that are typically 25 milliseconds long. Then, using specialized voice development software and/or hardware, 12 to 15 LPC units (coefficients) per frame are extracted. Further "hand" editing of these coefficients may also be required to eliminate errors introduced during the analysis process. The coefficients are then processsed by a speech synthesis chip which uses a mathematical model of the human vocal tract to simulate, as near as possible, the original speech signal. LPC speech derived from human input, like digitized speech, is very intelligible and easy to understand.

In those instances when unlimited voice output is required; for example, in a "talking" word processing program, a program with an extensive vocabulary, or a screen reader for a blind user, a text-to-speech translator is necessary. Text-to-speech systems translate ASCII characters into phoneme codes using letter-to-phoneme conversion tables and rules. "Exception tables" may also be included to handle the many irregularities of the English language. The phoneme codes are converted into the digital data needed to make the corresponding sounds, and then played back through the output hardware to produce words or word sounds. Additional processing techniques are employed to refine the prosody and pronunciation of the synthesized speech. While the textual data being spoken requires very little memory storage, the text-to-speech system can impose a subtantial amount of memory and processing overhead. As with digitized speech, synthesized text-to-speech output quality is directly related to the amount of memory used: the greater the complexity of the text-to-speech algorithm, the more computer memory is required.

Research

There has been relatively little experimental data which examines the value of educational software with voice output. Most of the existing research has focused on young children acquiring beginning writing and reading skills in both special education and general classroom environments. The recent proliferation of "talking software" should promote a greater increase in such studies; but until then, the results of a handful of studies provide a preliminary look at the benefit of speech-based microcomputer instruction.

Studies done at the UCLA Intervention Program for Developmentally Handicapped Infants showed that a microcomputer equipped with a speech synthesizer can be a very beneficial language acquisition device for developmentally handicapped children (Meyers 1982). Aside from impressive gains in the rate of language acquisition, both in comprehension and in production, this study showed that children using the voice synthesizers demonstrated other non-language benefits, e.g., increased attention span, improved fine motor abilities, and visual scanning skills.

Two studies, (Casey 1984) and (Pittelman & Levin 1985), have explored the effects of using a voice synthesizer to enhance the instruction of beginning reading with the language experience approach. Both projects studied five year old students in a classroom setting and found that microcomputer speech had very positive effects on instruction. In the conclusion of her report, Casey confirms that her study corroborates Meyers results at UCLA, only in a mainstream environment. Pittelman and Levin reach similar conclusions citing three areas in which speech-based software made distinct contributions to the language experience program: 1) more efficient use of teacher time and materials, 2) increased individualized and independent learning, and 3) increased student motivation.

One of the most comprehensive research projects involving computer speech and reading is presently underway at the University of Colorado. The basis of this study is the unique Computer-Based Reading and Speech-Feedback system which utilizes a text-to-speech synthesizer and a mouse or light pen (Olson, et al. 1986). When an unfamiliar word is encountered, it is highlighted on the screen and spoken, or it may be "orthographicallly and phonetically segmented" to improve phonetic coding skills. Although they conclude that " a number of important methodological issues need to be studied before the full educational potential of computer speech can be realized", their pilot work with disabled readers demonstrates that this group "enjoys using the system and they showed significant short-term gains in word recognition and comprehension when speech feedback is available."

Two recent studies involving computer speech and writing instruction (Kurth & Kurth 1987) and (Borgh & Dickson 1986) show equally favorable results in regard to the benefit of voice output. The Kurth study involved 46 children from two elementary schools enrolled in a summer writing class. The students were divided into three collaborative groups: those with a word processor and printer, those with a word processor and speech synthesizer, and those with access to a copy machine for making transparencies for sharing their writing with others in their group. It was shown that very young children can benefit from both a word processor and voice synthesizer, and that these devices seem to contribute to collaborative writing. Borgh and Dickson studied 48 children from second and fifth grade classrooms. The students wrote stories with and without speech output. Results showed that using a speech synthesizer led to increased levels of editing and that less-skilled writers were more motivated by hearing spoken feedback than their advanced counterparts.

The most thorough research published comparing computer speech with other methods of instruction is an evaluation of IBM's Writing to Read program (Murphy & Appel 1984). In this study several thousand children were evaluated before and after their instruction with the IBM instructional program. Students using Writing to Read showed significant advantages in numerous reading and writing skills over the control groups that did not use the program. Although it is unclear what specific benefits computer speech made to the overall success of the program, Writing to Read has set a standard for all speech-based software .

The above sampling of research studies offers a limited view of the potential of adding voice to instructional programs. The benefits of computer speech need to be demonstrated in more carefully controlled experiments. Given that the quality of voice output can vary so dramatically, these research results must be considered in light of the voice technology employed. A robotic text-to-speech voice may not be as effective as utilizing digitized voice in a reading program, whereas a creative writing program would clearly require an unlimited vocabulary system.

Products

Speech hardware and software that is used in the classroom falls into three general categories: 1) "turnkey" systems which include voice hardware and a series of instructional programs that use that hardware, 2) software which includes voice data that requires the use of a voice synthesizer produced by an independent hardware company, and 3) "talking software" that includes digitized voice data or a text-to-speech program that uses whatever sound and speech hardware is built into the microcomputer.

Writing to Read from IBM, the Computer Curriculum instructional programs, Prescription Learning's Ufonic Courseware, and programs from ESC are examples of "turnkey" packages that include both voice hardware and software. These packages typically offer several programs centered around a curriculm area and often include a management system as well as networking capability. These products usually employ digitized speech, and in such cases a hard disk is required to store the extensive programs with voice data.

Houghton Mifflin's Speechware series and the talking programs from Scholastic, which both use the Echo speech products from Street Electronics, are examples of popular educational software which require a speech output device available from another manufacturer. There are over 100 software companies in the US which offer programs that include compatiblity with some of the popular voice output products on the market. Apple is currently offering "talking" products from the above three companies as part of their Early Learning Series promotion for the 1987-88 school year.

The talking programs from First Byte and the Reader Rabbit program from the Learning Company are examples of single programs that take advantage of the digital to analog converter built into the Apple IIGS and require no additional voice hardware. The First Byte "software only" programs are based on a sophisticated text-to-speech system, while the Reader Rabbit program and others like it use compressed digitized speech.

The quality of the voice output of these programs varies dramatically, as does the price. Some of the "turnkey" packages that include numerous diskettes with extensive documentation and management software can cost in excess of $1,000, while the software only products and the single lesson programs which require additional hardware often sell for under $50. As with other educational materials, price does not necessarily correspond to the quality of the product.

Voice output is becoming a necessary component of special education, language acquisition, reading, and drill and practice software. Most of the leading educational software manufacturers have now added voice capability to a few of their products; as this trend increases voice will become a standard rather than a added feature. Ultimately, optical storage technology will eliminate the memory constraint problem with microcomputer-based speech. At that point it will not be a question of whether to add voice to instructional media, only a matter of whose voice to add.

References

Laura Meyers, The Use of Microprocessors to Promote Acquistion of Beginning Language and Literacy Skills in Young Handicapped Children, UCLA (1982)

Jean Casey, Beginning Reading Instruction: Using the LEA Approach With and Without Microcomputer Intervention, (1984)

Susan Pittelman and Kathy Levin, a report from the Program on Classroom Processes: Skill Development--Language Arts. NIE (ED) (1985)

Richard Olson, G. Foltz & B. Wise, Behavior Research Methods, Instruments, and Computers, 18, 93-99 (1986)

Karin Borgh & Patrick Dickson, The Effects on Children's Writing of Adding Speech Synthesis to a Word Processor (1986)

Ruth Kurth and Lila Kurth, A Comparison of Writing Instruction Using Word Processing, Word Processing with Voice Synthesis, and No Word Processing.... AERA paper (1987)

R.T. Murphy and L. R. Appel, Evaluation of the Writing to Read Program, ETS (1984)

TAKING THE COMPUTER INTO THE CLASSROOM TO IMPROVE TECHNICAL SKILLS AND SOFTWARE.

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ABSTRACT

Utilization of technical software within undergraduate health professional education is limited, yet computerization is prevalent in the workplace. Transition toward computer integration is slow, partially because of hesitation to teach specific applications rather than general principals. To test the validity of this assumption, technical computer applications were incorporated in consecutive classes using varying sequences of didactic and computer applications. All students were familiar with basic computer functions. Each computer application was demonstrated "live" with the aid of an overhead projection liquid crystal screen prior to individual use of the software. Student performance on classical manual methodologies improved more rapidly following use of the computer programs than in previous classes which had no computer interaction. Each group made recommendations that have resulted in two revisions of the software used for this evaluation. This is a valid method for increasing technical capabilities of students while improving both quality and versatility of software utilized by health professionals.

INTRODUCTION

The continued escalation of computerized equipment within the clinical laboratory and health care environment has begun to focus attention on the discrepancy between work and educational settings. This is particularly true in the educational process for medical technologists (MT) and medical laboratory technicians (MLT). In a survey of 206 university and 253 hospital-based MT/MLT programs (ref 1), only one third of the universities and one fourth of the hospital-based programs were using or had used computers for instructional purposes. Many of these applications have been reported by educators at national professional meetings. Many of the programs being utilized were coupled with textbooks, i.e., medical terminology text and tutorial sets; or were math problems, chemical titrations, or self-assessment questions sets that were amenable to computerization. These were different in nature from computer applications in other areas of biomedical education. In 40 citations of computer-assisted instruction from the biomedical literature, 26 described applications of PLATO. Five general descriptive articles, 4 applications of clinical simulations, a single use of Super PILOT, computer generated exams, and a self-paced instructional unit were also listed. On the other hand, a simultaneous search of the Educational Data Base (ERIC) produced 8677 citations for computer-assisted-instruction (ref 2). Clearly a discrepancy exists not only between the applied and academic settings, but also between technical and other educational environments.

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Supported in part by grants from COOPER Biomedical/Organon Teknika, Malvern, PA.; VAULT Corporation, Newbury Park, CA.; and Vice President, Research and Sponsored Programs, University of Southern Mississippi.

Efforts to address this problem during professional training have been receiving more attention during the past several years. Computer interest groups among educators are appearing in national professional organizations, and feature columns or articles are appearing in the professional literature. As a result of these efforts, there is an increasing awareness that one of the major factors adversely affecting integration of computers into the professional curriculum is the lack of computer literacy among instructors. Twenty-five percent of the institutions in the survey noted above responded that lack of instructor preparation was a major difficulty encountered when considering CAI. Many of these instructors received their training before the emphasis on computer literacy or computerized instrumentation took hold of the workplace. Closely linked with lack of computer skills is a perceived difficulty in integrating CAI into program curricula. It is not difficult to imagine situations when differentiating between these two factors might be difficult at best. Two additional deterrents to using computer aided instruction that receive substantial support are lack of appropriate software and the cost of implementing CAI. The latter three are the most frequent justifications used by most educators for not utilizing the computer in the educational environment. When equipment, software and / or funds are available, the transition toward computer program integration has continued to be slow, ostensibly because of a hesitation to teach specific applications rather than the general principles needed in the education of multicompetent technologists. This study was undertaken to test the validity of these assumptions.

OUTLINE OF STUDY AND METHODS

Four successive classes of Medical Technology students took part in this study during the on-campus portion of their Senior year. The first class served as a control group for the rest of the study since half of these students had no computer experience prior to beginning the study while the rest had extensive computer skills. This class participated in the prototype testing of the format, content and security for a computerized self-assessment question set written by the author with two intended purposes. First, the questions were to provide a method by which the student could test mastery of essential fundamental concepts in a non-threatening way. These questions were automatically scored for the student, but a grade was never assigned that related to performance. Secondly, the program was designed to develop and to practice basic computer skills (keyboarding, data entry, computer function, etc.) necessary to implement other commercial applications utilized in the clinical laboratory. All students were encouraged to make corrections, suggestions or improvements in the operation of the program and/or format of the material. Security of the program and material were treated as privileged patient information and students were encouraged to suggest "reasonable measures" to insure continued confidentiality. Revisions were made the same day requested and the modified program was returned the next morning for reevaluation. Security was ultimately solved by VAULT Corporation's FILELOCK™ security system. Subsequent utilization of FILELOCK™ in other applications resulted in recommendations to the company for improvements in the handling and security afforded by this system. These recommendations are now being incorporated into their program.

This first class was asked to provide a preliminary evaluation of three commercial computer programs designed to aid in the identification of antibodies directed against red blood cell antigens. These students were proficient in accomplishing this identification by classical manual methods. Evaluations were to reflect ease of operation, logical sequence of operations, accuracy of results, and perceived educational benefit of the program. Evaluations were made without knowledge of provider or of cost. Programs were assigned in random sequence without knowledge of the author's preferences. More than 85% of the students concurred with the author's choice of COOPERATE™ by Cooper Biological; however, they provided several unique perspectives and recommendations for changes that should be made prior to utilization of the program within our immunohematology course. The most notable of these recommendations was the incorporation of a menu module to facilitate switching among modules within the program. That addition was made by the author, but the manufacturer has subsequently incorporated a menu in Version II of their program.

Classes two through four were provided with the computerized self-assessment question sets beginning with the course sequence preceding immunohematology. Subtle changes were again recommended by the second class, but the question sets have remained unchanged since, and no further recommendations have been received for data security. Evaluation of the COOPERATE™ program as an educational tool was incorporated into the curriculum during the antibody identification portion of the immunohematology course. By the beginning of this course, all students had mastered the computer functions essential for operation of the self-assessment or COOPERATE™ program.

The COOPERATE™ program was introduced to the classes, with the assistance of an overhead projection liquid crystal screen, in the following sequence. The second class received all didactic instruction and had developed essential manual skills necessary for antibody identification prior to introduction of the COOPERATE™ program. The third class was presented with the COOPERATE™ program prior to relevant theory and technical information. The fourth and most recent class was presented theoretical information by using the COOPERATE™ program as a live format to illustrate relevant technical concepts.

All students were asked to provide written evaluations of the program specifically addressing the following points: 1) What can the program do that you are unable to accomplish?; 2) What can you do that is not programmed into COOPERATE™?; 3)What problems, suggestions for improvement and/or corrections do you have as a result of using this program?

RESULTS

The students approached the evaluations from unique perspectives which produced unexpected but beneficial results. One of the aspects of their evaluations was the obvious fact that they did not know how the programs were supposed to work; therefore they tried to make the programs behave according to their logic. This approach provided a wide variety of amusing, if not frustrating results when unanticipated programming oversights or "glitches" appeared in the program. Numerous discussions ensued, with the end result being a self-satisfied ease with the computer and strengthened self-concepts because of a clearer understanding that they were "smarter than the computer".

Even with these similarities, each class expressed a distinctly different perception of the technical computer program which seems to reflect the manner in which the program was introduced. The first class spent most of their time evaluating the three programs and seemed to approach their evaluations as a game. They spent far more time "just playing" with the programs than subsequent classes and were among the loudest complainers when they finished the course and couldn't continue with the computer applications. Performance on classic manual methodologies improved more rapidly in the second and third class than in any previous class which lacked computer interaction. Both classes two and three were able to achieve minimal proficiency with the COOPERATE™ program, but with somewhat different expressed objectives. The second class, which received COOPERATE™ after their manual skills were formed, utilized the software to validate their manual test results while exploring other possible combinations that would yield the same, or similar results. The third class, which received COOPERATE™ before technical instruction, used the software more as a learning tool. Both groups of students made additional recommendations, suggestions and/or corrections that have been forwarded to the manufacturer and are scheduled to appear in Version III.

Results from the fourth and final class do not parallel any of the three previous classes. The final presentations of theory and technical information using COOPERATE™ was as a live format to illustrate relevant new concepts. These students seemed to perceive the software only as an instructional tool for classroom demonstration and utilization of the program at other times was minimal. These observations may be the result of the manner in which the program was presented, but based on the overall performance of the class, may be attributable to variables present in this class and absent in previous classes. Two of these variables were inadvertently present in this class because of unforseen scheduling differences from previous classes. The fourth class was only half the size of previous classes with a more homogeneous, less competitive mix of students; and the immunohematology course concluded immediately before Christmas holidays rather than at mid semester as previously. This sequence of presenting theoretical information by using the COOPERATE™ program as a live format to illustrate relevant technical concepts will be repeated with a class beginning in mid-January to reevaluate these discrepant findings.

Data security for the COOPERATE™ program is accomplished via the PROLOCK™ security system supplied by Vault Corp. Previous evaluations of the FILELOCK™ and a new PC architecture diagnostic program, TECHLINE™, facilitated recommendations to simplify and speed future program operation. Numerous suggestions provided by students have been incorporated into a final draft that is currently under evaluation in preparation for Version III of COOPERATE™. Similar suggestions were made for FILELOCK™ and TECHLINE™. An updated version of the latter program has just been received for reevaluation for incorporation in future courses.

Utilization of these commercial programs in their unmodified form as they appear in the professional workplace has provided synergistic learning experiences while providing valuable feedback to manufacturers for software improvement.

1. J M Clerc, Lab Medicine 18,773 (1987)
2. H M Neisler, unpublished data.

CLASSROOM MICROCOMPUTER APPLICATION FOR SCHOOL HEALTH PROGRAMS: PRESENT AND FUTURE

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ABSTRACT

The role of lifestyle in personal health has been clearly recognized. Earlier research related to tobacco use, substance abuse, nutrition and exercise further establish that habits formed during school age years continue through adult life and are a major determinant of health during the latter years of life. Health risk appraisal technology (HRAT) has been widely used to raise individual awareness and reduce health risks for adult populations. As adult lifestyle and personal health behavior patterns have their foundation in earlier years, it is reasonable to expect that any impact on the health habits of school-aged youth of today will effect the adults of tomorrow. Reported here are the initial findings of an HRA designed for school-age youth administered to 9th and 12th graders in three states in the United States of America. This study provides a scientific basis for further refinement of technological applications for school health programs.

BACKGROUND AND PURPOSE

Over the past decade the Center for Disease Control (CDC) and others have developed and disseminated an adult Health Risk Appraisal (HRA) for use in the public domain. Research has shown that this computerized instrument is an important tool to assist health educators as they shift emphasis from reactive health care to proactive, preventive care. By so doing a high proportion of present day morbidity and premature mortality can be prevented. Moreover, the increasing frequency of substance abuse, teen pregnancy, violent behavior, risk-taking behavior, and sexually transmitted diseases, including AIDS, are among the many problems afflicting a significant number of our youth. Application of HRA technology (HRAT) is an excellent approach to identify, prioritize, and target interventions designed to deal with these and other school health problems.

The first purpose of this paper is to suggest a synthesis of four existing technologies. A second purpose is to propose a future enhancement to make the current application more adaptive for a broader range of individual differences between and among students.

The current technologies utilized here are: (1) educational technology emerging from programmed instruction methodology; (2) school health technology from a longitudinal study of School Health Education Evaluation (SHEE); (3) Health Risk Appraisal technology (HRAT); and, (4) classroom audiovisual (TV-VCR) coupled with microcomputer technology using a portable optical mark reader (OMR).

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Future applications to offer greater enhancement will replace TV-VCR with a microcomputer driven compact video disc-interactive (CDI-I) with random access. This optical, radial, laserdisc (as it is sometimes called) uses compatible analog encoding which enables the disc to function as a video encyclopedia. Using an interactive mode, this configuration of hardware will provide for the development of school health software to test, diagnose, teach and to provide a scientific, individualized program for changing health attitudes and health risk behaviors.

PRESENT STUDY

In 1986-87, the Health Promotion section of the Tennessee Department of Health and Environment along with the Department of Health, Leisure, and Safety at the University of Tennessee at Knoxville initiated a plan to collect information on the health beliefs and practices of 9th and 12th graders in Tennessee. Valid information on knowledge, attitudes and behaviors regarding health risk factors was sought in an effort to provide direction for a statewide school health programs. The 9th and 12th grades were chosen for experimental and practical reasons. A software program entitled Teen Wellness Check (TWC) developed by the Rhode Island Department of Health was selected because of its face validity and widespread use.

An eight minute instructional videotape was produced to standardize instructions to the student participants. The videotape introduced the study, defined the concept of health risk, and informed the students how to complete the TWC questionnaire. Confidentiality and total anonymity were guaranteed in the videotape by demonstrating that the optical mark reader (OMR) eliminates reading of participant's response by any person other than the respondent.

METHODS.

A VCR player was used to introduce the study and the HRA questionnaires were distributed during a 50 minute class period. Students were instructed to score their answers to the questionnaire on a specially designed computer mark sense card. A microcomputer, printer, portable optical mark reader (OMR) device, and HRA software were present in the classroom. As students completed their HRA questionnaire, they would insert their answer card into the OMR, and within minutes receive an individualized printout that detailed both positive and negative health habits, along with recommendations for behavior change. The use of computer equipment on site and nearly instantaneous feedback eliminated the necessity of personal identifiers on the output, and thus guaranteed confidentiality to the respondent. The nearly universal popularity of computers in schools functioned to further enhance the educational messages provided.

Aggregate group summaries of data were made available to the appropriate school personnel immediately follwoing administration of the HRA. This allowed the HRA to function as a health risk needs assessment prior to instruction. Educational effort could then be focused in specific high-prevalence or high health risk areas, and directed toward specific sub-groups identified by the HRA (e.g., students needing AIDS orientation and/or Family Life instruction).

In addition, regional or state-wide data summaries could be used to direct more comprehensive health education planning.

FINDINGS.

Table 1 compares the results of the TWC from three states, Tennessee (TN), Rhode Island (RI) and New Mexico (NM). Although a sub -set of the 9th through 12th grades in each state was studied, only data from 9th graders in each respective state are represented in Table 1.

TABLE 1

TEEN HEALTH RISK FACTORS FROM 9TH GRADERS IN THREE STATES

Risk Factors	TN(87)	RI(86)	NM(86)
Cannot swim	10%	9%	12%
Overweight by 20+ %	3%	2%	2%
(+) Hitchhike/picks up h/hikers	5%	(11%)	(12%)
Exercise < 3xs/week	43%	39%	40%
Nutritionally poor diet	67%	63%	65%
Don't brush teeth daily	13%	10%	13%
(+) Any smoking	(18%)	(20%)	14%
(*) Any alcohol drinking	19%	23%	28%
(*) Rides/drives under influence	22%	18%	30%
(*) Don't use seat belts regularly	67%	79%	52%
Mix alcohol and drugs	11%	13%	13%
(+) Highly stressed	(22%)	(25%)	46%
	N=1780	N=2188	N=>27k

The three risk factors designated with an asterist (*) are noteworthy because the difference in rates within these sets is consistently four percent or greater. The three risk factors identified by a plus (+) have been categorized based on the polarity of their rates. Within this category, two of the states reported quite similar rates (highlighted by parenthesis) for a risk factor while the rate for the third state was markedly different. The remaining six risk factors (no special marking) were reported at relatively similar levels among the states.

For the first time in Tennessee, valid data covering a broad range of adolescent health issues has resulted in recommendations based on a systematic study instead of on assumption of need. The investigators are advocating the conversion of these findings into actions which will address specific school health problems based upon demonstrated need and hard data. These findings have implication for the development of a broad scale but flexible health education curriculum for implementation through grades K-12.

FUTURE APPLICATIONS

The present hardware configuration includes: (1) TV-VCR; (2) microcomputer with a monitor; (3) printer; and (4) an optical mark reader. The interactive and computer assisted instruction (CAI) capabilities of the health risk appraisal technology can be greatly enhanced by the addition of a microcomputer driven, random access, interactive video disc. With the addition of random access and interactive video capabilities, individual users and software programs will be provided with the potential for confidential assessment, individualized printouts for positive and negative health behaviors, and personalized intervention health education programs designed to reduce high-prevalance or high risk behaviors.

To illustrate the proposed application, assume that a teenage user has been assessed with a low level of knowledge related to alcohol intoxication and injury from motor vehicle accidents. An interactive CAI program could provide this user with an intervention experience designed to illustrate: (1) motor skill impairment related to alcohol comsumption; and, (2) blood alcohol level based upon the participant's weight, sex, amount of alcohol consumed, and the time used to consume the alcohol. The individualized intervention program could visually display the level of impairment, probability of motor vehicle accident and using a computerized game could demonstrate the driver's inability to avoid an accident. Further, using the random access video and audio capabilities, the user could be provided with an expert presentation by a recognized authority and be allowed to seek individualized answers to typical questions. In brief, the interactive, random access video disc offers unlimited software development opportunities for school health programs. While development cost will be great, the increasing demand for comprehensive school health programs will provide favorable cost vs video ratio.

CONCLUSIONS

The use of immediate response health risk questionnaires in the classroom can do much to enhance the quality and content of school health programs. Perhaps the greatest of all the advantages described is that of guaranteed anonymity provided by the optical mark reader. Other methods such as coded questionnaires or telephone interviews designed to collect sensitive and confidential information from adolescents remain suspect by this sub-population. Guaranteed anonymity and immediate feedback to both student and teacher encourages participation and takes advantage of that illusive "teachable moment". Affordable pre and post assessment of health risk levels can also function to evaluate effect of classroom instruction pointing out both strengths and weaknesses of health curricula.

REFERENCES

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THE INTEGRATION OF COMPUTERS INTO THE PRIMARY SCHOOL CURRICULUM.

Derek Blease.*

ABSTRACT

Support and training provided by MEP, MESU and the Local Education Authorities has gone some way towards helping teachers see how a computer might become a valuable classroom resource. However, a closer look at schools indicates that there are still many teachers who lack the confidence to attempt even the most tentative experiments with computers as a part of their daily routine. Following the provision of adequate hardware and software the key problems seem to be:

a) appropriate training,
b) adequate on-site technical and pedagogical support,
c) the provision of a sufficient number of plausible examples of good practice.

This paper raises these issues within the context of an experiment conducted in a Leicestershire primary school over three school terms and indicates that successful integration of computers into the primary school curriculum depends, in part, upon:

1) a change in teacher attitudes
2) an increase in self-confidence.

INTRODUCTION

Booth Wood is a Leicestershire open-plan primary school of some 250 pupils, seven staff and a non-teaching head. The third and fourth year juniors are divided into two vertically grouped classes and are taught in adjacent open-plan areas at one end of the building. Any work undertaken by each class is readily visible to the other as well as to the rest of the school. The two teachers (both female), had little previous experience with computers when the project started in September 1986, although they had undertaken a small ammount of work with two programs. In order to avoid creating a totally false situation it was decided to introduce just two additional BBC computers, one for each of the two classes. (The school had just one computer of its own to be shared between seven classes). These two computers remained for the sole use of those two classes until the end of the project in December 1987. The project was intended to provide training and support for the two teachers and to observe how they coped with the problems of fully integrating the new technology into the curriculum.

TRAINING THE TEACHERS

The training programme as originally visualised, proved to be very inadequate. The intention was to provide a general overview of the

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kinds of things which could be done with a computer in the classroom without suggesting in any way what the two teachers should do. An extract from my own notes illustrates my feelings at the time:

> ".....in March I had painted a very gloomy picture since at that time I felt that little, if any, progress had been made. I had set up what now seems to be a very casual training programme which I had hoped would meet the needs of both teachers. It had started with a general overview of types of software and how they might be used, and some general reading of teachers' accounts of what they had tried. This was followed by a few specific sessions looking at particular programs when I thought the teachers required them. My feeling was that for some reason, little of my suggested activity had been taken up, and that they were still clinging to two programs which they had been asked to try by a colleague of mine some time earlier. Whenever the computer was in the classroom I felt that it was there as an addition to, rather than as an integral part of the overall lesson plan. It was almost as if the two teachers felt they had better get the computer out just because we were there. My concern was that I had been unsuccessful in convincing them that the computer could become part of their overall view rather than something just tacked on at the end. The question was - how could I change that view?"

The problem seemed to be one of confidence. The training programme needed to provide the right kinds of experiences to help build up the teachers confidence in their ability to cope when perhaps some of their pupils knew more about the computer than they did. One of the teachers remarked on this point:

> "Probably there is an element of knowing the program. I think you need to know the programs better than the children so when they come up with problems then, you know, if they're stuck you can help them."

Certainly there is a suggestion here that she would prefer not to admit to the children that she did not know the answer. One might venture to suggest here that this problem consists of two dimensions, firstly that it is a question of **technical competence**, the knowledge of which keys to press or the various functions of the program, and secondly the teacher's willingness to take on the role of "**partner in learning**" with the children rather than seeing herself as the "**answerer of all questions**". It is the second of these two which requires a significant attitude change on the part of the teacher, but it may be dependent upon her mastering the first.

PROVISION OF TECHNICAL AND PEDAGOGICAL SUPPORT

It now seemed necessary to provide experiences which would, at the same time, encourage them to make the leap towards appreciating the advantages of the computer for themselves (attitude change), and to build up enough confidence to be able to try things they weren't sure about in front of the children. The immediate solution seemed to be a more structured and directive approach to training providing regular opportunities for them to 'play' and 'experiment' with the computer away from the pressures of school and classroom.

In the classroom we decided to allow the teachers to use our research assistant, Joyce, as if she were a parent/helper. She would do whatever they directed, but only as and when told. The purpose of this was to allow the teachers to think about planning for the use of the computer without, at the same time, having to cope with its minute to minute supervision. A regular weekly training programme was organised and supply cover was provided by the headteacher every Wednesday afternoon. Both teachers came to the University to work with me. Joyce joined in this training too since she had no previous computer training or experience and we thought that the shared experience might help to cement closer relationships between observer and observed. The sessions themselves always started with a formal talk and demonstration by me, this was followed by some practical work, but then I would go away and leave them to work and discuss on their own. However I always remained available should they need further help. This proved to be most successful. Here are some extracts from a conversation with the two teachers on this point:

> "When I started the training sessions with you did you understand what I was talking about?"
>
> Pat: "At the time yes, it was afterwards we tended to forget things but usually between the three of us we would manage to remember...."
>
> "Could you remember what I had said afterwards?"
>
> Janet: "Not often. Joyce, Pat and I used to talk it out together, some people would remember some bits and other people would remember others. It would all come together as a joint venture."

Clearly this approach was having some effect, but it is important to remember the need for support to be on hand when needed, as indicated by the following extract:

> "In the beginning did you confidently feel that you could try things out in school?"
>
> Janet: "Some things that I'd become happy with, but when things started to go wrong and I'd forgotten things, I'd perhaps start it off and I'd forget something I needed to know and the manual didn't seem to provide the information, that was frustrating. If you approach it with a group of children, and you think you've got it together and you find you haven't, it just sort of falls flat."

The question of motivation, really wanting to master the computer, arises here too:

> Pat: "I think the main thing is that it assumes too much knowledge, everything seems to assume too much knowledge. There was nothing that was so basic that we could understand it without referring to you. You really have to want to do it, to fight your way through that. lack of time is a major point because at

> the end of the day you've still got your ordinary preparation and marking....your own family to cope with. There just never seems to be the time to actually sit down and try new things."

PLAUSIBLE EXAMPLES OF GOOD PRACTICE

For many teachers there is an inherent problem with providing published examples of 'good practice' since those selected for publication are often seen as the work of 'high-flyers'. For the most part the MEP "Classroom Reports" were chosen for their relevance and clarity. However, this extract seems to indicate, for these two teachers at least, that the examples provided were of passing interest only:

> "Did you find time to read the articles I gave you, did they help at all?"
>
> Pat: "Yes I did. It was interesting at the time to read about what some other teachers had tried, but I can't remember what they were about now."
>
> Janet: "Yes I read them but I don't think I absorbed it too well."

Perhaps if they were to re-read the articles now, after a year of classroom experience themselves, they might take on a new and more significant meaning.

TEACHER ATTITUDES AND SELF-CONFIDENCE

It is difficult, in such a small space, to demonstrate the extent to which the attitudes and self-confidence of these two teachers have changed. One full year of computer use in their classrooms has had a profound influence on them and the knock-on effect for the rest of the school has been remarkable. Our two teachers defend their right to exclusive use of the computers against all attempts from colleagues to borrow them. The parents have become motivated to raise funds to buy more computers for the school. The real turning point for the two teachers was a successful local studies project using a database to record and analyse information from the gravestones in a churchyard. It provided the first opportunity for the work of both children and teachers to become fully visible to a wide audience. Janet organised an assembly around the database work in which the children talked about what they had discovered, interesting wall displays appeared around the school containing not just computer printouts, but pieces of the children's writing about themselves using the computer. At last the teachers felt they had something worthwhile to show for their efforts, but at the same time this final comment indicates a more fundamental change in the minds of the teachers:

> Pat: "The work and the display drew many comments from a variety of sources - other staff, parents, visitors, but perhaps more pleasing, from other children in the school. Obviously this was gratifying and it did mark a major milestone in the project to date. We both felt more at ease with the computer and felt more able to ad lib in a crisis. The effort now seemed much more worthwhile."

EXPERIENCES OF NEW TECHNOLOGY IN PRIMARY SCHOOLS

Paul A Deponio

ABSTRACT

Experiences of using the new Information Technology in Primary Education fall into four major categories which can be summarised as follows: The Current Trends and Developments, Use of Appropriate Teaching Styles, Curricular Implications and the Way Ahead. Within these categories there are issues of Hardware and Software development, management and organisation, pupil and teacher response, learning strategies and implications for the future educational policies.

INTRODUCTION

The introduction and use of new technology in primary education is not new - it has been going on for many many years. Sometimes the new hardware and software was welcomed and used effectively. Other times it met with great passive resistance and faded into oblivion. There are occasions when it has virtually changed the style of classroom teaching e.g. the introduction of disposable workbooks and the use of colour in textbooks. On the other hand all it did was to change the management and organisation of the classroom as did the controversial introduction of the ballpoint pen and the extinction of the pen-nib and ink. Some of these changes came about at the express wish of educationists, others came about as industry produced new products for the business world which were unintentionally useful in schools. The latter may or may not have been true with the introduction of the microcomputer into schools a few years ago but today it is the educationists who are making the demands on the designers of hardware and software.

CURRENT TRENDS AND DEVELOPMENTS

At the moment, in Lothian Region and most of Scotland, there seems to be a general acceptance that the standard system or set of components for use in schools is as follows: a BBC Microcomputer, a 5.25 inch floppy disc drive and a medium resolution monitor. This system is often on a trolley which is moved between classrooms when teachers' needs or the timetable dictate. A recent development has been the introduction of the Word Processing chip and this has led to the rapid appearance of dot matrix printers on the trolley.
With all this hardware came the software to run it. In the early days the type of software generated was what is termed "Drill and Practice" and owed much of its pedigree to the linear programming of the old Learning Machines and the so-called 'Programmed Learning'. While these simple programs demonstrated the versatility of the microcomputers they did not reflect the needs or hopes of the teachers. However this has altered dramatically in the last four years due mainly to the setting up of The Scottish Micro-electronics Development Programme (now a division of SCET) and Micro-electronics in Education Programme in England and Wales. From these organisations came software which was designed by

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teachers, for teachers and programmed by professional programmers. Market forces have persuaded Software Publishers to produce software which has to be educationally viable otherwise it will not be bought by teachers.
The development of peripherals extended the use of the microcomputer educational sphere. Originally the microcomputer was used only by older children in primary schools since the QWERTY keyboard and the poor software prevented younger children from interacting with the machine. However the development of the Concept Keyboard has allowed programmers and teachers to produce software which young pupils and pre-school children can now use very effectively in their classrooms and Nurseries.

APPROPRIATE TEACHING STYLES

The introduction of IT into the classroom has brought about a change in the teaching styles employed by classroom teachers. The microcomputer, at its simplest level of use, has freed teachers from the tedium of correcting pupils' work and has allowed them to spend more time working with pupils. However other uses of the microcomputer enable the teacher to have pupils learning in various ways within the same classroom at the same time. There is much more scope for children to work as individuals or in very small groups on work which has been tailored to their specific needs.
Sometimes the work in the classroom may stem completely from work being carried out on the microcomputer or the machine may simply support work initiated by the teacher. The teacher may use software to stimulate an interest in an aspect of the curriculum in a way not possible before. Today's teacher is often spending time managing the pupils' learning as they react to stimuli from the microcomputer. This management is not merely reactive but very deliberate and comes after reviewing the software and preparation of learning materials which the pupils will need. Management of the classroom environment now includes the siting of the computer system and has to take into account factors such as screen clarity, noise levels and possible distraction to other pupils.

CURRICULAR IMPLICATIONS

Some of the major changes brought about by IT have come in the curriculum. There has been a significant shift in both the content of the curriculum and the skills taught from the more traditional reference book / pencil and paper orientation to acceptance of access to a wide based information system where the recording and communication of ideas on paper is no longer the priority it once was.
In the early stages of writing in the primary school great store is now set on developing collaborative writing with children working in a group of two or three co-operating to create a piece of writing. This is often keyed into the wordprocessor by the pupils, working in shifts, or by the teacher and then printed out so that each pupil has a copy for themselves. This leads onto the production of class magazines etc. in later years. There has been an increase in the collection, handling, organisation and management of data by pupils. This data is often connected with a study of the local environment but there have been occasions lately where schools have used an electronic mail system developed for schools to collect data from areas very distant from their own.

The increased use of Adventure Games and Simulations has allowed pupils to have more practice in constructing hypotheses in solving problems and then testing them on the computer. Events and situations can be recreated on the screen so that pupils can have realistic experiences without problems of time, resources and possible danger.

THE WAY AHEAD

What lies ahead for IT in education? Six years ago schools were using 32K BBC micros which loaded software from cassette recorders and today schools are beginning to use PC compatibles to work on for Wordprocessing and Desk-Top Publishing. A great deal of developmental work is being carried out on Interactive Video for schools and the recent reduction in Laser disc production costs will probably encourage its introduction to schools on a much wider basis. It is doubtful if schools as we know them now will have altered much before the year 2000 but if the amount of IT hardware in classrooms can be increased significantly then teaching will certainly take on a new impetus and to be teaching then should be quite exciting both for teachers and pupils. The major thrusts seem to be heading in the continued development of Desk-Top Publishing using PCs; LOGO as a language for problem solving and as a language for Control Technology; Interactive Video as a reference library resource and for very powerful simulations; and the increased use of commercial software for graphics.

The way ahead has great implications for educational authorities and the decision makers therein. Much work has been necessary in providing In-Service for teachers already in school with microcomputer equipment but more is needed as new IT hardware is developed. Teachers need time to become familiar with the use of Interactive Videos, Modems, Control Technology, LOGO and Floor Turtles. With this In-Service comes the need for funding of equipment purchasing and the staffing of Support Units which would provide both curriculum and technical backup for schools. As always the real future of any educational innovation lies not with the teachers already in schools but those who are in training or about to begin their training for the Teaching Profession. Universities and Teacher Training Colleges will have to ensure that their students know enough about IT to use it effectively in their teaching. Not just for their own sake but so that their pupils will be aware of IT and its potential. It is a sobering thought to realise that students about to enter training will be teaching children who are just being born and that these same children will be leaving school in the year 2000.

If the rate IT has developed in the last eight years is surprising, what will the next 13 years bring?

COMPUTERS - FOR WHAT?

Alistair C Thomson *

ABSTRACT

The potential for confusion in the use of computers in education is unlimited. If you listen in to a conversation between members of a group of educationists talking about computers in education, you might be forgiven for thinking that they are all talking the same language, and are all communicating in a worthwhile and constructive manner. Unfortunately, the chances are that they are not. There are several reasons why this is the case. These include the variety of fundamentally different applications for computers in education, and the looseness of terminology. For example, we all know that "CAL" means "Computer Assisted Learning" - but what does that mean?

The speaker asks the question "What do we want to do with computers in education?" and concludes that although the answers might be satisfactory (and sometimes exciting), the question is wrong.

PERSPECTIVES

There are many opportunities for misunderstandings in discussions of the use of computers in education. If a group of teachers get together to talk about, for example, the teaching of languages in the primary school, then all of those involved in the discussion will be talking about the same thing.

If a group of teachers get together to talk about the use of computers, however, there will certainly be several fundamentally different perspectives represented in the group, without these perspectives being fully acknowledged, or even recognised, by the members of the group. This leads to misunderstandings, and as a result many discussions lead nowhere, except to frustration.

An example will help illustrate the problem. Let us imagine that it has been decided to hold a meeting of teachers interested in using computers in Primary education. A circular is issued, asking for such teachers to come together on a certain date to discuss issues of common interest; only teachers who have actually used computers in education are invited. On the day, the delegates are asked to describe their interests, as a starting point for discussions. The meeting was small (this was in the days when very few Primary school teachers were interested in

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using computers - that is, not very long ago) and consisted of eight teachers; their experiences were as follows:

- an Assistant Head who had used a computerised database of pupils' information to help with administration
- a teacher who had used drill and practice packages in number skills
- a teacher who was keen on problem solving using Logo
- a teacher who had developed an "electronics in the Primary School" module, based on a standard control technology kit
- two teachers who had (separately) developed a series of lessons in computer awareness
- a teacher with a degree in Computer Science, who had re-trained to become a teacher because children were more interesting than computers
- a teacher who had never used a computer before.

This was quite a mixed bunch, and it was hoped that there would be a good discussion of the use of computers in education because of the rich variety of experiences brought to the meeting. Except, of course, for the teacher who had had no experiences with computers (people wondered why that teacher was there at all!).

Unfortunately, the meeting was a disaster. The Assistant head felt isolated, because no-one could understand his interest in computerised administration; the teacher with the drill and practice packages felt lost because of the teacher who was interested in problem solving, and who kept talking about the application of recursive procedures; the teacher who had developed the control technology course felt frustrated because no-one cared about how important it was to introduce children to technology; and the two teachers who had developed computer appreciation materials had nothing in common, because one had simply written a course in BASIC, while the other one had developed materials on the implications of the use of computers on society.

Well, the meeting wasn't quite a disaster, because the teacher who had never used a computer, and had viewed the results of the meeting with some dismay, discovered (over coffee) that the teacher who had a degree in Computer Science was interested in using the computer to help in the promotion of a range of teaching and learning strategies. They got together later and produced a series of packages with the emphasis on control of learning by the pupil.

Unfortunately, no-one used these packages because teachers generally like to think that they, and not the pupils, are in control of learning.

THE PROBLEM

The problem is straightforward. There are as many ways of "using a computer" as there are of falling off a cliff (and some of them are just as painful). Thus, we have CAL (Computer-Assisted Learning), CAL (Computer-Aided Learning), CAL (Computer-Administered Learning), CAL (Computer-Automated Learning), CAT (Computer-Assisted Teaching), CAT (Computer-Assisted Training) CAL again (Computer-Assisted Lessons), CALL (Computer-Assisted Language Learning), and CAI (Computer-Assisted Instruction); then we have CML (Computer-Managed Learning), CBL (Computer-Based Learning), CBT (Computer-Based Training), CMT (Computer-Managed Teaching)...

By this time, mathematicians will have noticed two things. Firstly, if we take any word from the set

{Assisted,Aided,Administered,Based,Managed}

followed with any word from the set

{Learning,Teaching,Instruction,Training,Lessons}

then hyphenate the word "Computer" on to the front, we arrive with one of 25 different objects of the type under discussion. You could even write a computer program to automatically generate all 25 objects (- entries should be sent to the author, and the one with the most optimum code will win a major prize). Secondly, there are subtle but important differences in the meanings of these objects. That is, any one user of any one object will mean one thing when using that object, and will mean something else when using a different object. Or vice-versa.

And all of this is supposed to help us to describe how we use computers in education.

Non-mathematicians will not have failed to notice that each and every acronym starts with a "C" - and that fact, I submit, is the problem. It seems that, the moment anything new comes along in education (and elsewhere), it is given top billing, as if it were important. This might be fair enough, and is certainly understandable (human nature being what it is), but we are by now surely beyond the first shy self-conscious blushes from computers as they submit to the will of education.

And they do submit. There are numbers of schools throughout Europe, where exciting things are happening in the classroom, and where the computer is involved. There are also numbers of schools throughout Europe where exciting things are happening in the classroom and where the computer is not involved. The fact that the second number is currently larger than the first is of less concern than the fact that the sum of these two numbers is still small. It is this statistic which should occupy educationists, rather than the numbers of computers in the classroom, or the number of ways of starting an acronym with "C". If computers have any claim to a lasting place in education, it is reflected in the fact that the first number is growing more rapidly than the second.

THE SOLUTION

There will always be acronyms to tease the tyro and numb the neophyte. We cannot ban them. We cannot even produce a dictionary of meanings, because we would never agree on these meanings. But therein lies the solution, for if we can't agree on the meanings behind the words behind the acronyms, then the acronyms themselves must be truly meaningless.

I propose therefore that we increase the number of acronyms substantially. In this way, those who enjoy using them will be satisfied, and those who have the misfortune to have to listen will be so confused that they will believe the users are talking rubbish. The easiest way to increase the number of acronyms is simply to place a number of educational resources into a set, along with "Computer", and use this set to choose the first letter of our acronym. The other two sets can remain as above. Thus, we can take as our first set

{Computer,Blackboard,Overhead projector,Audio,Video,Class, Worksheet,Book,Peer,Self,Teacher,Parent,Resource....the list is beautifully endless}

and, using our three sets, produce acronyms like SAI (Self-Administered Instruction), which sounds interesting if a little risque, and RBL (Resource-Based Learning), today's bandwagon. We now have at least 300 acronyms from which to choose, a la carte.

The simplest solutions are often the best, because, entirely by accident, we have displaced the computer from pole position, and have acknowledged the existence of some other important attributes of the learning environment.

CONCLUSION

This whole discussion started with the uses which can be made of computers in the classroom, and looked at ways which have been devised to provide shorthand answers to the question. It found that the answers were acronyms, and this was unsatisfactory. Yet, it asserted that "good practice" does happen, with and without the computer, and this good practice is what we are striving for. Perhaps then, the question was wrong. Perhaps we should ask about learning experiences, and classroom activities, and so on, and let the computer fend for itself. I, for one, know that it can.

A Research on the use of Educational Software in the Classroom

Montserrat Boix, Belén Urosa, Luis Zorita

ABSTRACT

After the early years of the introduction of New Information Technology in education we find the urgent need of developing software adapted to educational needs. In addition, it´s necessary a deep research on the repercussions of N.I.T. in teachers and children.

As a part of this task, our work try to create a scenario of requirements and qualities needed in educational software for supporting teaching and learning activities.

Spanish situation

The educational use of computers in Spain, had the starting point in the begining of this decade. As an answer, policy makers decided in 1984 initialize an experimental programme in order to study the possibilities of the use of this new methodology in spanish schools.

The three key points in this programme are: teacher training, hardware selection and distribution and software development.

Teacher training and hardware distribution (with I.B.M. compatibles) is being carried out with regularity.
Currently, the different components of a integrated package,are used in the spanish classroom. This first step has been very interesting and useful option.

Our Thinking

Around the use of computers in the schools a lot of different expectations have been created.
But, everybody knows the cycle:

expectations, discussions, scarcity of difussion
and results,oblivion

followed by other technologies in educational environment.
In order to break this cycle next three years are very important. Some results and the spread of these results in the classroom are necessary to go on towards new goals.
People devoted to the introduction of N.I.T in education not only must encourage teachers to use computers. They have to show that their use is interesting and improve their teaching activities.

This is why some materials, mainly educational software is needed.

Some steps

In the Spanish Center for Educational Research and Documentation (C.I.D.E.) we think that, at present, the key problem is educational software for supporting teaching activities.We need a critical mass of such materials.
But the process to elaborate software is hard ... and very expensive. That means, we have to concentrate our efforts for these three next years.
In this sense, maybe we have to choose. Primary or secondary school? experimental sciences or social sciences?.

In order to give an adequate answer (for this crucial period) we have given some steps:

- -creation of a specific library with a very large sample of programs used in U.S.A. and Spain for I.B.M. compatible equipment.
- -study and analysis of these programs from a pedagogical point of view.
- -elaboration of a guide for software evaluation.
- -a selection of some programs that we consider more interesting.

Now we think is the moment for external validation. That means, is the moment for a pedagogical research on the use of some programs in the classroom.

The research

The aim of this investigation is to analyse:

- -the effets on the use of some educational software in children.
- -the possible ways to use them by the teachers as didactic resource.
- -the most interesting pedagogical features that this software has in order to offer to software developers some ideas from the pedagogical point of view and stimulate their production.

The sample of software is composed by four programs. Three have been elaborated for spanish working groups as a result of a public competition one year ago, the fourth has been elaborated in United States.
The general purpose of these programs is to help teachers in some specific topics in the curriculum using the power of this new tool. That means, improve the knowledge of some small subjects using computers.

Two essential questions for us in selecting these programs have been:

using these programs do we get some pedagogical advantage than using some other media?

Is justified spend time and money developing these programs?

Of course software developers must answer to these questions and explain why and where, but in our situation, we will try to answer with this research.

The software selected covers different areas: Experimental Sciences, Social Sciences, Maths and language arts.

The programs are , in different measure, opened. That is, children can decide different goals using them, but the possibilities are centered in specific topics. So, we have a research-tool to help in the elaboration of studies on dynamics of population (graphics included), a simulation-tool for chemistry laboratory, a drill-tool for functions studies in plane and space geometry and a tool to produce a newspaper.
I'ts interesting to explain that this software has some written material. For instance, and depending on the case teacher and pupil guide, examples of his use in the clasroom, aims to be reached, etc.

The research will be carried out in four schools (2 primaries and 2 secondaries).First the application, teachers will be instructedin the use of one program and after, they will decide when and the way to use it in the clasroom. The sample of children will be composed for 280 (half and half primary and secondary).

We pretend to determine the qualitative and quantitative changes between pupil and teachers such as:

-attitudes
-interests
-dynamics on the methodology in the clasroom
-motivation strategies
-academic performance
-team work capacity

The working methodology is groundedbased up in action-research paradigm, that means we will try to find possible rules of educational software production detecting:

-possible transferences to other areas of the curriculum.

-sugestions for the improvement of such programs

detected by teachers and pupil.
- dynamics created by different ways of introducing it.
- maximum and minimum time of intervention
- teaching style more adequate depending different modalities of programs.

COMPUTERIZED INSTRUCTIONAL SUPPORT : SUCCESS OR FAILURE?

B. Page*

ABSTRACT

Microcomputer technology, as a tool for the support of instruction is an application somewhat lacking in adequate experimentation and purposeful development regarding the human interface. Most computerized management systems are difficult to use, particularly for the novice, and require many hours of training before teachers will attempt to use the technology on their own. As computer technology has increased in power, it has generally increased in complexity rather than in simplicity and ease of use. Many of the existing software programs designed to help teachers manage instruction provide limited functions, making their use more burdensome than helpful. New technologies, new applications, new approaches to computerized instructional support are needed. They must focus on the human interface with the motto, "powerfully simple, simply powerful". Such applications are now within our reach, but we must plan for their realization.

INTRODUCTION

The term, Computerized Instructional Support, as used in this paper, is a purposeful attempt to add to and broaden the definition of computerized instructional management, commonly referred to as CMI (computer managed instruction) in the literature. The majority of CMI programs deal only with the scoring, recording, and reporting of student progress on objective tests. A few of the newer programs allow the user to create tests from an item bank (ref 1). The concept of instructional support includes the features of instructional management, and adds the linking of instructional materials and teaching strategies to learning outcomes and goals, or objectives. Associated with each instructional goal is a set of test items, a list of instructional materials, a set of graphic materials including unique maps, charts graphs, illustrations, and lesson plans or teaching strategies peculiar to each objective. It is the ambition of this paper to examine some of the difficulties experienced in the past by developers and users of computer managed instruction programs, and to offer a few possible solutions.

AIMS OF COMPUTERIZED INSTRUCTIONAL SUPPORT

Managing instruction is a duty teachers have wrestled with from the earliest days of formal instruction. Because of the time required to gather information, questions concerning how well each student is learning and what the next most appropriate learning experience is for each child have often given way to

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survival practices in the classroom which have frequently included teaching all students the same material from the same source (textbook) at the same time, and in exactly the same way. Indeed, good decisions--timely and learner responsive--require good information--accurate, timely, specific, and accessible. The effort required to derive "good" information about learners has discouraged teachers from seeking to obtain it by long-hand. Because computers are fast, accurate, and reliable in performing tedious, repetitive tasks, they have been heralded as the solution to problems relating to the management of individualized instruction, programmed learning, mastery learning, outcome based education, and other instructional processes which depend upon a management system to control the content, context, duration, and pace of instructional events. According to Smith (ref 2), no computer managed instruction program is effective unless it is "embedded in an effective instructional program. " The computer does not manage the instruction in most cases, it provides a support mechanism which contributes to effective instructional management. Computerized instructional support, in addition to the elements of instructional management, seeks to place at the fingertips of the teacher, resources and teaching helps to improve instruction and save valuable time.

In order to be of real value to teachers, computers must save time. They must be able to free the teacher from tedious tasks which detract from the teaching/learning act, and they must facilitate meaningful and appropriate educational decisions. In addition to storing, sorting and retrieving, information, computers ought to assist in the correlation of teaching outcomes with learning strategies and resources, and to put those resources at the fingertips of the teacher.

PROBLEMS WITH MICROCOMPUTERS AND PROGRAMS

A problem emanates from the scant communication between educators and computer designers. Educators have been left to their own devices to adapt existing technology to their purposes. The difficulty in making the computer do what is wanted has alienated many teachers from the world of high tech. Many teachers view the computer as a tool which increases the complexity of life rather than making work easier. Both software and hardware contribute to this problem by requiring vast amounts of time to study voluminous instruction manuals containing unfamiliar jargon and making inappropriate assumptions about the background of the reader. The problem is compounded by the inability of most computer experts to comprehend the fear and exasperation experienced by many computer novices. This author has witnessed teachers become physically ill at the thought of having to face the computer. The fear of pressing the wrong button and either loosing information or destroying something they could not afford to replace looms as an all too possible scenario which, due to poor system design, occasionally becomes a reality. And does it not always happen to the timid, distrusting neophyte whose confidence we are struggling to build?

Microcomputers have, until recently, created their own unique set of problems for programmers attempting to develop software for instructional management. The size of the databases required to contain the curriculum objectives, student and teacher information, test items, and other resources gave rise to modular programming--alternately loading portions of independently operating programs into the computer's memory--creating slow access to data, and disk swapping which increased the potential for errors, and the failure of both medium and equipment. The most simple programs were, and are today, menu driven, with prompts and error messages, often serving to confuse the beginner more than edify. As microcomputers have increased in memory and speed, more powerful programs have developed with them. Unfortunately, as the increased power has meant greater capacity and speed, it has been accompanied by equal increases in complexity. The multiple combinations of function keys, control keys, special option keys, while adding versatility to the programmer, and power to the programs, has very effectively widened the gap between the expert and the novice.

Teacher training in the use of computer managed instruction systems is a fairly consequential and expensive undertaking (ref 3). One of the large developers of a computer managed instruction program warns prospective purchasers of the financial commitment to staff training which must accompany the purchase of their product. Recently, Alpine School District in Central Utah was considering instituting on a trial basis, a well known commercially produced computer managed instruction program which cperates on microcomputers. A willing school faculty was selected, and district officials along with the school principal and selected teachers met with a representative of the computer software company. School district officials were asked to spend a sizable amount of money to have the software company train the school faculty, and school personnel were told to expect considerable frustration, and not to expect full implementation for up to six months. The computer program scored tests, recorded student information, and produced various reports. Promises were made that by the end of the school year, the program would also allow teachers to generate tests. The school principal, faculty and school district officials unanimously agreed that they could do a perfectly adequate job of frustrating one another for next to nothing, and decided to save their money.

Part of the problem in producing effective computer software for educators stems from the disparity between the vision of technocrats and the needs of classroom teachers. The need for simplicity, for example, in addition to speed and capacity, seems not to have been a very high priority of some computer programmers. Teachers need powerful, simple tools to use in support of teaching and decision making. Obviously, programmers are constrained by hardware when designing the user interface aspects of programs, and computer manufacturers, therefore, must accept some of the blame for the difficulty users experience with some software. for whatever reasons, There is a dearth of effective software which addresses the real needs of teachers.

So far, it would seem that a case is being made to answer the question, suggested by the title of this paper, with a conclusion that Computerized Instructional Support in indeed failing as a viable and important resource to very many classroom teachers. It should be acknowledged that there are successful instructional management programs in operation where classroom teachers have paid the price to learn the system, and have found a reward in so doing. (ref 4) Further, creative teachers continue to find and develop creative computer applications (ref 5). These are few in contrast to the potential, however, and unless the difficulty and complexity experienced with many of current programs in use, the use of such programs will continue to be minimal.

POSSIBLE SOLUTIONS

There is hope, however, for those who have avoided computers up until now, in anticipation that computers would become easier to use, and more friendly to ordinary people. The development of new mouse technologies and touch-sensitive screens may offer some possibilities for simplicity. The fairly recent development of a systemware package called HyperCard/™ by Bill Atkinson for the Apple Macintosh is an example of what can be done with a mouse, and a new concept in programming which helps the user to build links between "buttons" and "cards." The Alpine School District has developed an Instructional support system using HyperCard which links instructional objectives to test items, lesson plans, instructional media, graphics, student records, etc., and the user does not need the keyboard of the computer. All aspects of the program are accessed by simply pointing at a picture icon or a word on the screen, and by pressing the mouse button. The icon contains a hidden script which performs a function or completes a link to information stored in memory, or on a hard disk, or a CD rom disk, or any other medium for data storage. There are no help screens, no menus to go through, no instruction manual to read, no special keys to press to perform one function or another, only pictures to point at and all necessary instructions simply stated and visible on the screen at all times.

When computer designers and programmers begin thinking more about ease of use than of how fast or how large a program can be made, then the real potential of the computer to do some good for teachers in the support of intsruction will be realized.

REFERENCES

1. B. Farnsworth & J. Wilkinson, A Fully Integrated Management System for Tracking Student Mastery. T.H.E. Journl., Nov. '87 p 96-100.

2. R. Smith, Improving Instructional Management with Microcomputers, N.W. Reg. Lab., Portlnd. Oreg. Dec. 1981 26p.

3. D. Sutphin, Educating Teachers on Instructional Applications of Microcomputers, T.H.E. Journl., Feb. '87 p54-58.

4. W. Norris, Computer-Based Education: A 'Key' to Reform, Educ. Wk. Nov. 18, 1987, p28.
5. J. Nathan, Micro-Myths (Winston Press Minneapolis, Minn. 1984).

INTEGRATED LEARNING SYSTEMS IN THE REGULAR INSTRUCTIONAL PROGRAM

Eugene R. Hertzke, Ed.D *

ABSTRACT

Integrated Learning Systems and Computer Assisted Instruction are both terms currently used to describe the comprehensive use of technology in the regular classroom. Very few schools have progressed in this technology because the programs available seem expensive and are not perceived to be anything more than workbooks on a computer. The Central Kitsap School District views Integrated Learning Systems as an integral component in the regular instructional program -- not just a complement or supplementary. The use of technology as a primary conveyor of curriculum to students is in the embryonic stage of development. It is imperative this medium be expanded and perfected if productivity in the classroom is to be improved.

PROGRAM REPORT

A researcher comparing two national (USA) projects designed to increase student test results concluded that after several years of implementation both projects achieved nearly the same results and both showed minimal progress thereafter. He also concluded the current structure of the selected schools had become as efficient as they could be — any further growth in student achievement would have to wait until a new delivery system was devised.

It is the contention of the pioneers in educational technology that the use of the computer should be the heart of any new instructional delivery system. The computer and its attending software must become the major purveyor of information to the student. No, the computer will not replace the teacher; however, the role of the teacher in the instructional process will change dramatically. The computer can manage large amounts of information quickly and logically offers the teacher the tool to keep track of varying rates of progress and individual problems without being overwhelmed by record-keeping demands. By removing these administrative tasks from the teacher's role, the technology frees the teacher to give more attention to the management of the instructional program.

In a recent speech to the National School Board Association's Institute for the Transfer of Technology to Education, Mary Alice White, Professor, Teachers

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College, Columbia University, New York reinforced the above observations by stating:

"Many institutions and work settings have found their basic operations transformed through the use of technologies. Should not schools ask themselves a similar question, namely, 'If the job of schools is, minimally, to see to it that young people acquire information and certain communication and cognitive skills, do these technologies offer any learning or teaching value to these basic processes?' And the answer, I believe, is 'Yes,' that the essence of these technologies is intellectual.

These technologies change the nature of information itself. They change how we represent information. They change how we view information cognitively. These changes are at the very heart of education, of teaching and of learning. These information technologies might well be called the 'learning technologies.'"

The Central Kitsap School District began in 1981 to introduce the language and use of computers to all the fifth and sixth grades in the District. High School science and mathematics teachers also had use of computers in their classrooms. Soon computers were being used in remediation and special education classes. Computer games were also used as reinforcement for good behavior and exemplary work. This isolated use of technology is not the essence of integrated learning systems or computer assisted instruction. (For the balance of this paper integrated learning systems, **ILS,** will be used to designate these terms.)

ILS is defined as a delivery of curriculum by computer through sequenced software, networked hardware with a management system capable of reporting student progress data to the teacher. In contrast an ILS is not stand alone computers, drill and practice, solely remedial, random curriculum presentations, without a management system and without a curriculum scope and sequence.

With the above parameters as guidelines a staff committee began a search two years ago for a system which would start the school district into the instruction technology age. The WICAT and ESC systems were chosen for grades 7-9 and grades 1-6 respectively.

The WICAT system offers programs in the following areas: reading, writing, sentence combining, spelling, language arts 3-6, kindergarten - 8th grade mathematics, algebra I & II, geometry, French, English as a Second Language (ESL), computer literacy and typing. Any of these programs are accessible to a single student or group of students. All seventh and eighth grade mathematics students are scheduled into the lab two periods a week, all seventh grade students are scheduled for reading in two 30-minute periods per week, and special education students are integrated with the regular classroom. A non-certified aide operates the ILS lab; however, the classroom teacher continues to determine the specific lessons to which the student should be assigned. Reports are given to the teacher bi-weekly and include information such as achievement levels, the number of reteaching efforts required before the student achieved mastery of an objective, and the amount of time required to complete each objective.

The ESC system includes three components: (1) a comprehensive 1,500 lesson reading and mathematics curriculum for grades 1-6; (2) an on-site facility management service, which includes a lab attendant and a complete computer student management and performance system and: (3) a computer laboratory with 32 student workstations. The ESC system motivates students and individualizes instruction through a sequential and interactive curriculum. Higher order thinking skills are built into the lessons so students learning applications that go beyond the textbooks.

All first through sixth grade students are scheduled into the lab for a 25-minute period every other day for reading and for mathematics. Teachers generally accompany their classes to the lab to assist students on their lessons and in using the hardware. Some teachers cooperate with another teacher and each send half their class to the lab. This allows the teacher to have twelve to fourteen students for more personalized instruction. Because classes rarely exceed 28 students, several computers are available for other students. Very often these places are occupied by handicapped students who respond very well to the immediate feedback the systems can give them.

During the past summer teams of teachers compared the District's specific learning objectives with the objectives set forth in the ISL programs. A seventy percent compatibility was found. The teacher then identified the discrepancies which allows the teachers to be more precise in providing students with appropriate lessons. Teachers can introduce, reinforce or review a concept through the use of the ISL program with the possibility of each student having a different lesson. An evening class for high school students who have failed English uses the junior high ILS lab. Students take grammar on the computer using the language arts program for secondary students. A writing component is also used which includes keyboarding practice to improve typing speed. With minimum proficiency, the student can progress to the wordprocessing feature which allows a comprehensive critique of the student's writing and permits work in general entries, creating letters and writing typical reports. The teacher can duplicate reports on the printer and work with small groups of six or seven students to do a writing critique. While 30 students can be present in the room, all can be productively involved in personalized lessons.

To determine the success of the elementary ISL program, pre and past tests were administered. Overall a nine percent increase in achievement was obtained with students showing the most gains in mathematics where the need was the greatest. Second grade students, however, showed the greatest gain -- thirteen percent -- in reading. Teachers also noticed students using the ILS systems approached long problem solving assignments and story problems with less apprehension and more success. The latter point was borne out when testing data was analyzed and showed a significant number of students moved out of the lower stanines and more students appeared in the upper stanines. These findings are a real tribute to the lessons designed to develop problem solving and higher level thinking skills.

A new District task force on technology is studying where the District is in the implementation of technology into the regular classroom, determining where the District should be in 3-5 years, and devising a plan to get there. The Board of Directors and the top administrators strongly believe that with the involvement and support of the staff a totally new instructional delivery system built around technology can be developed. There is too much information our students need to learn to do it "the old fashioned way."

COMMUNICATING WITH PARENTS THROUGH TECHNOLOGY

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ABSTRACT

The use of technology to enhance instruction has followed a fairly regular progression, from the old days when we used "audio-visuals" to the present when many classrooms make use of computers. However, the use of technology to enhance *parent involvement* has not shown similar progress. In fact, the way most schools engage in interaction with the parents of the students seems to ignore the available electronic and communications technology. Six underused technologies with high potential for improving parental involvement are: (1) telephone systems; (2) computer graphics/desktop publishing; (3) photocopy equipment; (4) photography; (5) video cameras and (6) automated computer calling.

RATIONALE FOR COMMUNICATING WITH PARENTS

The influence of the home environment is widely recognized as one of the most powerful determinants on development and educational potential. When children enter school, the effects of classroom instruction are enhanced if parents have been involved as true partners in the child's education. The partnership between teachers and parents can only be built on a foundation of rich and frequent communications, yet this condition is rare and difficult to establish in most school settings.

Motivation is not the reason that teachers and parents do not communicate frequently. Most parents are concerned about their childrens' education and most teachers know that parent partnerships help the child and the school program. But teachers are busy, parents are busy, and most of the traditional approaches for parent involvement take major committments of time and energy. Through the creative use of existing technical systems, the richness and the frequency of home/school communications can be increased *without any significant increase in time demands on either teachers or parents*. Six forms of technical tools with high potential for use in parent involvement are described below in the form of recommendations.

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TELEPHONES

Recommendation: *Each teacher should have a separate phone line and answering machine.* At the end of each day, the teacher records a summary of the days learning activities, homework assignments, and suggestions to parents for helping students at home. As the teacher leaves, the machine is set on automatic and parents can call the number, hear the information and assist the child. The call takes less than a minute, and the answering machine does all the work. If parents want to speak directly to the teachers, they can request a call back. The teacher can review these messages from a remote phone or at the beginning of the next day, and return the calls at the earliest convenient time.

COMPUTER GRAPHICS AND DESKTOP PUBLISHING

Recommendation: *Every school should have one or more desktop publishing and computer graphics programs for the composition and production of printed information for parents.* School and classroom newsletters, enriched progress reports, school handbooks, policy statements and all other information sent home to parents should be designed and produced on the most current computer graphics programs. The value of clear design, multiple fonts and sizes for print, logical format, enriched graphics and other publishing features has seldom been realized when communicating complex information to parents. The speed and efficiency of current software in producing these materials can also increase the frequency of distribution and increase the flow of information from the school to the home. High quality "camera ready" originals are essential in producing multiple copies.

ELECTRONIC PHOTOCOPY

Recommendation: *Every school should have a modern photocopy machine for use in communicating with parents.* Every piece of print communication sent from school to home must compete with the flood of paper from all other sources. Spirit duplicators and mimeograph machines are obsolete, and the ability to enlarge, reduce, collate, and produce transparencies is needed. Newsletters are one of the most frequently used means of school/home communication, and should be duplicated on contemporary equipment. The same is true for producing transparency materials for parent meetings; clear, high contrast visuals can increase the interest and the understanding.

PHOTOGRAPHY

Recommendation: *Teachers should have easy access to automatic 35mm and "instant" cameras, with supplies of film and access to fast developing.* If pictures are really worth a thousand words, then teachers ought to be taking instant pictures to send home and making slides to use in parent meetings. Photography can help capture a record of events that parents cannot experience any other way. New cameras are virtually foolproof, and teachers can produce good pictures with a little orientation and practice. Pictures taken in the classroom allow the parents to see their children in the classroom context at times and in situations that they could not experience directly.

VIDEO CAMERAS AND PLAYBACK EQUIPMENT

Recommendation: *The school should have at least one portable video camera and playback unit, with at least 2 large monitors.* In the same way that cameras can capture still reality, video recording can reproduce the sights and sounds of the classroom so that parents can view the curriculum in action as it happened. Videotaped sequences of special classroom performances or routine student learning experiences can give parents an accurate and contextually-rich understanding of their child's educational program. Tapes can be used for major parent meetings and in small group or even individual conferences between teacher and parents. With a camera in the room and a monitor in the hallway, parents who do not wish to be in the classroom can observe the "live" action on the screen. Equipment with some editing capability would be highly desirable.

COMPUTER CALLING

Recommendation: *One computer in the school should be equipped with digital voice equipment and automated software to make outgoing calls.* Computer calling was introduced in some secondary schools for the single purpose of reporting absenteeism, but second generation systems are now being used for more positive parent communication. With easy file management, the computer can store many different messages in the natural voice of the sender and place calls to students' homes after all school personnel have left for the day. With rates of 60 - 90 calls per hour, these systems can reach many families with only a few minutes of preparation. The systems record calls completed and not completed, so other means can be used for parents that were not contacted. Any message from reminders about the schedule for parent meetings to emergency information can be delivered to any or all student homes with computer calling.

INTEGRATION OF TECHNOLOGIES

Taken separately, some of these systems or pieces of equipment are already present in many schools. Their use is far more frequent for instruction or organization purposes than parent involvement. However, integration of these six ideas into a "maximum impact" model has promise of making parent involvement both better and easier. For example, the desktop publishing programs and the modern photocopy equipment have obvious linkages. Slides taken of certain events can be included in video tapes for parent viewing. The computer calling system can suggest that parents call the answering machine number for parent education instructions over the weekends. The applications of these technologies to parent involvement are limited only by the creativity of the professional staff. Full utilization of these systems can make great strides toward partnerships among parents and teachers, with the students as the direct beneficiaries.

WHAT ADULTS REALLY WANT IN SOFTWARE DESIGN

K. Watkins*

ABSTRACT

Despite the strong plea of Knowles in 1983 for the computer industry to take the characteristics of adults as learners into account in the design of software, adult learners continue to experience significant problems learning to use new software programs. Research on computing as an encounter with an alien culture supports to this anecdotal data. Strategies which may address these concerns include those for dealing with trial-and-error, self-directed learners and user modeling of learners' errors in using software.

WHAT ADULT LEARNERS SAY

In a graduate course on Adult Learning and Development, students describe a self-directed learning project. Each year, many students elect to write about their experience learning a new software program or their first experience using a microcomputer. Consistently, the process they describe goes like this: "First, I sit down, boot up, and start using the program. When I come to something I can't do, I look in the index for it using whatever term seems logical. I prefer, though, not to have to look anything up at all. If, on the other hand, I boot up and can't even begin to use the program, I simply don't use it. I guess you'd call my learning method trial-by-error."

Of course, trial and error learning is inefficient. And many adults do read the manual first, or have someone else teach them how to use the program. But most prefer to "just use it." Perhaps the computer seems so much like the already familiar typewriter or calculator that it seems like it should be easy enough to use. Nevertheless, this inefficient method of learning led to a number of preferences voiced by these adults. One suggestion (also in Knowles ref 3) was that large indexes are needed with many terms listed to describe a function (not just "cut and paste" but also block, moving text, copying text, deleting text, etc.) Quick access to help either through the use of a part of the screen for lists of commands and/or help directories or other reference card techniques were valued. Programs which punish the user for random errors were also not well-received. Since the user did not read the manual and doesn't know, for example, that accidentally striking a "Q" and an escape key simultaneously deletes the page, you can imagine the anger and confusion when it occurs. Programs which first query the user with "Do you really want to do that?" (and automatic page saving) save trial-and-error learners a great deal of frustration.

These adult learners voiced considerable impatience with running up against the limits of their chosen software. Just when they had begun

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to use the program with some ease, they would try to do something and the computer would not respond appropriately. Exhaustive searching would yield no solutions. Finally--only as a last resort--this self-directed learner would call for help either to the salesperson who sold the software or to some toll-free number given in the software for support. At this point, the learner discovered that the software did not perform the needed operation. It's easy to suggest that buyers should know what they want a software program to do before they buy it. But, since learners are usually learning their capabilities vis-a-vis the software, they do not yet know what they will want the software to do. What learners want is a software program that will teach them new capabilities--and then expand with them in an almost self-renewing process. Currently, software is upgraded to reflect new computer capabilities. These adult learners' concerns suggest that it should also be upgraded to accommodate the users' changing capabilities through such things as the inclusion of a series of diskettes in a software package from basic to advanced. These adult learners want to start with software that is immediately useful--so a basic new learner version that they could "just use" might satisfy them more than the instructional diskette often provided with many software programs. Or, more programs could offer simplified ways to add new commands. Software authors might also think in terms of a yearly subscription fee for a service where users send in their diskettes for modification as new capabilities are developed and/or needed by the user somewhat like encyclopedia yearbooks.

Critical to this discussion is awareness of the adult as a self-directed learner capable of growing open-endedly. There is not a sense of "This is appropriate to the third grade level." which one finds with children's materials. The learners choose how far they will go with this learning project. It is thus frustrating when the software won't also grow as far and as fast as the learner does.

Adults want software that will cater to their desire to learn on their own, but that will also not insult them with useless gimmickry, "cutesy" language, or child-like graphics (ref 1). Special attention to tone (Is it paternalistic or condescending?) and language (What is the reding level? Are examples targeted to adults, etc.) will enhance software quailty as well as its acceptance by these adults.

CONCERNS OF ADULT EDUCATORS

Adult educators have a history of contentiousness with the microcomputer revolution. Perhaps the most well-known argument was that offerred by Malcolm Knowles (ref 3) who "found a worm in his apple" and said that the microcomputer industry was in jeopardy of alienating adults with their lack of attention to the needs of adult learners in software design and documentation. He cited their failure to recognize that adults need to know why they need to know something before they will spend a long time learning it; that adults are task-centered in their learning; that they have a wide range of experiential backgrounds relative to use of the computer; and that adults have a deep psychological need to be self-directing which means that adults will resent being talked down to or being controlled or manipulated by peremptory instructions. The industry responded that they had already addressed his suggestions to field test manuals with adult users, to index manuals using everyday words, to copy edit carefully, to use a common command language for a given type of equipment, to ensure that local sales representatives know the software they sell and to build user networks. Industry spokespersons suggested that Knowles' problem was one common to older adults who had less success with learning to use a computer due to fear of the technology--a phenomena they said was rare among children and young adults (ref 4).

Research conducted by Sproull, Kiesler, and Zubron (ref 7) with 208 entering liberal art students compares learning to use a computer with encountering an alien culture. Encounters with an alien culture are characterized by reality shock (79% of the students said this was very true of computing compared to 20-27% for English, math and social science courses), confusion. 59% for computer courses vs. 20% or less for other courses, attempts to regain control (higher for computing); and when control is unsuccessful, to make unconstructive attributions (students in computing tended to attribute success to luck), and to experience anger and withdrawal (over 70% said of computing "This course makes me angry.") Computer science had the highest percentages of potential dropouts and mixed cases and only 8.1% whose responses indicated their potential as "recruits" to the computer culture. "Computing is not just something new, it is also something strange. Its spatial and temporal characteristics, controllability, and nature of feedback are unlike those of other technologies...When a student is reading a history book, the page never goes blank. If a student's pencil break, he or she can sharpen it. If a student is doing a physics assignment, the first wrong digit he or she writes on the page does not generate an immediate cascade of error messages." (ref 7, 33) These results suggest that young adults may also find learning to use a computer intimidating. Indeed, unlike both Knowles and the computer industry spokespersons who view the problem as inherent in the learner, Sproull, et al's results suggest that the problem may be in the culture of computing.

Some adult educators are concerned that using computers will isolate learners, make them passive, discourage self-expression, or promote a value of machines over people (ref 5). These concerns lead adult educators to ask computer software developers to adapt the machines and the software to the learner, rather than asking the learner to adapt to this strange new culture. (Ibid.) User modeling is one way courseware developers are attempting to do this (ref 2, 6) which may also hold promise for commercial software development.

USER MODELING FOR THE METACURRICULUM

User modeling is "the name give to the task of gathering information about an individual user that can be used to guide the behavior of an intelligent teaching, tutoring or monitoring system." (ref 6, 32). Keller (ref 2) notes that systems theory teaches that to control a process like how a student learns something requires a model of that process. The overlay model directs attention to where the learner's behavior differs from that of a master performer (ref 2). This technique enables courseware developers to map the process the learner uses and to determine their progress in obtaining a match with the expert's process. The core idea of user modeling is that the courseware will be more helpful if students are directed to material at their own level. Providing instruction which starts where learners are is a a key characteristic of adult learners (ref 3). If an adult is an excellent writer, yet new to using a word processing software program, many errors may be the result of experimentation with the limits of the software, a lack of understanding of the programming approach, or of the limits of the machine. User models may capture erros which learners make in mastering the subject of a computer-taught course, but not the errors learners make in using the computer or the courseware. Such errors are partially addressed as "noise." The meta-curriculum in this instance is learning how to learn to use computers. More attention to this curriculum could lead to more effective software design.

Whether developing courseware or commercial software, developing a model of how the adult learner learns to use that software may aid developers in presenting the content and in retaining potential computer dropouts. Just as Ross, Jones, and Millington, 1987, (ref 6) envision using a blackboard system to monitor user skill development, a similar technique might monitor user's use of help menus, bad commands, undo last command, etc. in commercial software and periodically suggest instructional support available for common errors. This approach is especially helpful for these trial and error learners. In a more sophisticated and costly approach, users might access a software developer's billboard to ask how to solve a problem. Common problems and their solutions would then form a new database as well as pool of information for software revision.

What is needed is a reframing of the task of microcomputer software design from machine or sales driven design to learner-centered design (ref 3). Strategies that are effective for courseware could also greatly enhance commercial software. Software developers must patiently guide these often reluctant, sometimes anxious adults through the process of learning to use their software.

REFERENCES

1. C. Kasworm and C. Anderson, "Perceptions of Decision-Makers Concerning Microcomputers for Adult Learning" in D. Gueulette, Microcomputers for Adult Learning, Chicago: Follett Publ, (1982).
2. A. Keller, When Machines Teach: Designing Computer Courseware. New York: Harper and Row, (1987).
3. M. Knowles, "Malcolm Knowles Finds a Worm in His Apple," Trng & Dev Jrnl, 37,5, 12-14 (1983).
4. E. Leon, "Byting Back: The Industry Responds." Trng & Dev Jrnl, 37,5, 18-20, (1983).
5. L. Lewis, "New Technologies and the Future." The 1990 Handbook of Adult Education, P. Cunningham and S. Merriam (eds), San Francisco: Jossey-Bass, forthcoming.
6. P. Ross, J. Jones, M. Millington, "User Modeling in Intelligent Teaching and Tutoring," in R. Lewis and E. Tagg (eds), Trends in Computer-Assisted Education, Palo Alto, CA: Blackwell Scientific Publications, Inc. 32-43, (1987).
7. L. Sproull, S. Kiesler, D. Zubron, "Encountering an Alien Culture," Jrnl of Soc Issues, 40,3, 31-48 (1984).

SPREADSHEET MATH FOR MIDDLE SCHOOLERS

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ABSTRACT

In an effort to include in the mathematics curriculum of the middle school topics that would be of interest to the learners as well as to facilitate application of the mathematics concepts being presented or reviewed, a set of lessons on spreadsheet mathematics was developed. A Michigan State University professor, working in conjunction with the mathematics teacher at the Vicksburg Middle School in Vicksburg, Michigan, designed, produced, and implemented five two-hour lessons. The lessons were highly structured, with the content presented using the overhead projector and a demonstration computer system attached to a large screen monitor. In addition, there were ten computer systems in the room for use by the students in the hands-on activities. Teacher support material was also produced to enable teachers with little or no computer experience to use the materials with no outside assistance. In general it was found that the lessons did hold the attention of the students, did allow for review of middle school math concepts, did present spreadsheet concepts which were readily transferable to other spreadsheets, and were usable by teachers with no formal training in computers or spreadsheet operation.

INTRODUCTION

Numerous studies related to the topics which are included in the middle school mathematics curriculum have indicated that there may be far too much redundancy in the topics traditionally included in the curriculum. Consequently, a short course in spreadsheet math was developed and tested in a middle school math class in the Vicksburg Middle School, Vicksburg, Michigan. This short course had as a general goal to teach the operation of spreadsheets, and had as a sub-goal to provide a real life setting for the review and application of the mathematical concepts taught in the middle school math program. Beginning with an introduction to spreadsheet terminology and the manipulation of existing spreadsheet files, the course included the steps to follow in creating spreadsheets and doing projections through modification of data and recalculation. The course concluded with a demonstration of Lotus 1-2-3, with the students finding easy transfer of spreadsheet manipulation techniques to a much more sophisticated spreadsheet than the one on which they had learned.

INTRODUCTION

Because of reports of concern regarding the selection and instruction of topics in the middle school math classes, an effort was undertaken to enhance the typical middle school math program by the addition of a short course on concepts related to spreadsheet math. It appears that because of the redundancy in the math program, many students find that middle school math for the most part is a review of concepts previously studied. Because of this fact, there seems to be an increase in the number of discipline problems among the students in these classes. In considering alternatives to be employed in such a situation, it appeared that to add a computer component might be one way of alleviating some of the difficulty. Rather than implementing a drill and review program, so typical of computer applications in the public schools, it was decided to create a course in which the mathematical concepts could be applied while computer concepts were being learned. Hence the focus on the electronic spreadsheet and the mathematical applications implemented in the spreadsheet.

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TOPICS INCLUDED IN THE COURSE

A total of five lessons was produced to introduce the students to the concepts related to spreadsheet math. The topics for these lessons are as follows: Lesson 1, Introduction to the Spreadsheet; Lesson 2, Creating a Spreadsheet; Lesson 3, Spreadsheet Applications 1; Lesson 4, Spreadsheet Applications 2; and Lesson 5, An Introduction to Lotus 1-2-3. Each of these topics requires two class periods for the presentation of the content, and approximately one hour of student time for the quiz and the hands-on activity.

DESIGN OF THE INSTRUCTIONAL MATERIALS

For the presentation of the information on electronic spreadsheets, a structured approach which contains seven components was implemented. This approach involves the instructor as the basic presenter of the information. As the information is presented, the instructor demonstrates using the computer with a large screen monitor attached. As the students become more acquainted with the keyboard and the commands, they substitute for the instructor as the operators of the demonstration equipment.

The five components are included in each lesson to answer questions often asked by students. The first component, the *Overview*, provides a brief description of the entire lesson and in effect states in general terms what the instructor will be presenting during the lesson. The overview is designed to answer the student question, "What is this lesson all about?" The second component, the *Objectives*, provides in general terms what it is the students will be learning and answers the question, "What will I be able to do if I master the content in this lesson?" The objectives, often called instructional objectives, are written in quite simple terms and provide the learners with somewhat more detail concerning their goals in learning.

The third component is a set of *StructuredNotes*. Since it has often been noted that the learners frequently do not know what it is they are required to be putting in their class notes, the structured notes guide them to record in the provided spaces the essential facts. The structured notes generally begin with a review of material presented in previous lessons. This review section is used to answer the question, "What do I have to recall from previous lessons to be successful with this lesson?" With the review completed, the structured notes then provide the guidance needed by the learners as the new materials is presented. This section of the structured notes is used to answer the question, "What really is the important information in this lesson to which I should pay close attention?" The structured notes then conclude with a summary section designed to answer the question, "Now, what were the really important elements of this lesson?"

Following the structured notes, the students are provided with a *Quick Quiz*, designed to answer the question, "How well have I mastered the content of this lesson?" These quizzes are used with immediate feedback devices and, in order to reduce the threat often present in testing situations, the students are informed that their behavior on the quiz is not being recorded. Finally, each lesson concludes with an *Activity*, a series of hands-on activities designed to answer the question, "Can I really use all the things that I have learned?" It is at this point that the effectiveness of the lesson can best be measured, since almost all of the objectives are measurable through hands-on activities.

GENERAL OPERATION OF THE CLASS

In these math classes the instructor begins each session with a review of previously-taught concepts by displaying five problems on an overhead transparency. The students work out solutions to the problems and then students are randomly selected to share their solutions. As soon as the five problems have been explained, the spreadsheet portion of the class begins. It has been quite amazing how many times the problems done in the review can be referred to in the spreadsheet lesson. It appears that because the mathematics used in spreadsheets is often no more difficult that middle school math, there is a high correlation between the reviews and the spreadsheet activities.

Since each lesson may take two periods to present, at the beginning of the second period the students have a brief review of the overview and the objectives, and then the lesson continues with the new material. It is often possible for the students to complete the quiz on the second day. Then with the structured notes and the quiz completed, the students are assigned to the classroom computers for their hands-on activities. These activities are programmed to take approximately one-half hour, and will be completed by the students during the next several weeks. All students will have completed the activities prior to commencing with the next lesson in the series.

TEACHER PREPARATION AND SUPPORT

To provide the classroom teacher with the support required to be able to be successful in the use of these materials, a special instructor guide was developed. Within this guide there was an attempt made to place all the information that most teachers would need to be successful in teaching the concepts related to spreadsheets. Since the information to be presented by the teachers was contained on overhead transparencies, the instructor guide was designed to hold all the transparencies. This was accomplished by three-hole punching all the transparencies and then slitting them from the hole to the margin. That way the transparencies could be easily removed from the notebook, used, and then "popped" right back into the notebook. In addition, copies of each transparency were placed in the teacher guide, and where there were blanks on thetransparencies to be completed by the teacher during the class, the required information was printed on the paper copy of the transparency. Also, accompanying each transparency was a series of suggestions regarding teacher activity during the time any particular transparency was in use. It appeared that this degree of support was useful for the teachers, and also that such support would be adequate even for those teachers with little experience with computers and spreadsheets.

RESULTS OF PRELIMINARY ASSESSMENT

Several findings concerning the use of these lessons in the middle school appear to be important. First, because the material is computer-related and is almost totally new to the students, there is a high degree of interest shown by the students. In fact the problems of discipline so often associated with middle school math classes appear to be nonexistent. A second finding relates to the high degree of correlation between the mathematical concepts taught, or reviewed, in middle school math and the mathematical concepts involved in creating spreadsheets. Invariably, during the presentation of the information on spreadsheets, it is possible to refer to one or more of the review problems done by the students at the beginning of the period. It appears that the middle school may be the most appropriate place to introduce electronic spreadsheets. A third finding relates to the applicability of the spreadsheet concept to many areas of interest for the middle school student. Spreadsheets are often introduced through the use of a typical household budget, and when this was done it was quite apparent that the students gained a good deal of insight into the cost of operation of the typical household. Then with the opportunity to manipulate the amounts in any budget category and note immediately the way the bottom line was affected, some most interesting comments were made by the students. But in addition to budgeting, it was shown how spreadsheets can be used to make calculations in such varied activities as changing amounts of ingredients in recipes based upon the number of individuals to be served and in keeping records for athletic events such as baseball, basketball, and bowling. A fourth finding relates to the generalizability of the concepts learned. All the instruction was provided using the Radio Shack Color Computer with the *Spectaculator* spreadsheet program. When the opportunity was provided for the students to use Lotus 1-2-3, the transfer of learning was most evident. In fact, the students found it much easier to use Lotus than Spectaculator because of the increase in on-line helps. So there was a high degree of transfer of concepts between spreadsheet programs, moving from one of the older, less powerful systems to one of the newer and much more powerful systems. Such experience shows that the type of equipment used in education is far less important than the way the equipment is used and the concepts which are selected to be taught.

SUMMARY

With the increasing interest in revising the content presented in the middle school mathematics programs, it appears that one element that can be added with real benefit for both teachers and students is the unit on spreadsheet math. By providing a highly structured approach with an adequate amount of teacher help, teachers with little or no experience with either comptuers or spreadsheets can function effectively with little or no training. In addition, by providing adequate structure for the students, their time during the teacher presentation can be used far more effectively, and following that, the time of hands-on operation can be well spent. By using a variety of applications in the teaching of spreadsheet operation, it appears that the concepts related to spreadsheet applications can extend far beyond those of the math classes. In future use of these lessons it is expected that coordination with teachers of other subjects will enhance the applicability of spreadsheets to an increased variety of subject matter areas,

SCHOOLS,SPREADSHEETS AND SCIENCE

G.Strack*.

ABSTRACT

Increasing importance is being placed on Science Education in our schools. Many of the processes of science can be enhanced through access to current software and new technology. Generic software, particularly spreadsheets, provide a useful tool that can make an effective contribution to current practices and provide an opportunity for advancement, through a change of emphasis.

INTRODUCTION

Frequently as a part of a scientific investigation students record data in tabular form. Simply recording the results can often be the end point of an investigation, but if calculations on these figures are required then the limiting factor is often a combination of time available and knowledge of the necessary mathematical functions. For many students the demand to function mathematically in a lesson other than mathematics itself, is almost impossible. The use of a spreadsheet however, can help overcome these problems.

INFORMATION TECHNOLOGY AND SCHOOLS

Through a variety of initiatives, including the M.E.P. and more recently the D.T.I., schools have been inundated with software covering a broad spectrum of subject areas. Much of this has been of indifferent quality and has contributed little to improving the learning processes of our children.

Numerous inservice courses for teachers have been organised to support the use of ephemeral software which often bares little relationship to the needs of schools. Much of this software has encouraged the use of the computer for short periods of time and has fostered the frequent moving of the computer from classroom to classroom. On this basis when we consider the total exposure of a child to computers, it does not add up to a very significant period, particularly in the Primary School. The child also sees the computer as being divorced from subject areas and in the same way as their teachers, look forward to their computer time, when over a period of a week, or even less, everyone has a go on the computer regardless of its relevance. Unfortunately, less emphasis has been placed on the use of the software tools which can facilitate work already being done, which can enable work that ought to be done and which provides an opportunity to attempt things not previously done.

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INFORMATION TECHNOLOGY AND THE PROCESSES OF SCIENCE

In the proposed National Curriculum 5 - 16, it is intended that Science is allocated 20% of curriculum time. The theme of Information Technology however, is expected to be taught through other subjects and is not allocated a period of time on its own.

Increasing prominence in science education is being attached to activity and experience rather than on knowledge to be acquired and facts to be stored. A number of key processes therefore need to be experienced. These include observing, communicating, measuring, recording, classifying, recognising patterns, predicting, controlling variables and investigating. Many of these processes can be enhanced by exploiting the tools that information technology provide. Not all of which are immediately obvious.

Observing is not the simple passive process that we often tend to assume it to be. When students are observing they are constantly selecting, judging, structuring. predicting, testing, and comparing the raw data captured through the senses. Without all this largely unconscious processing, it would be impossible to make sense of anything. The sheer bulk of irrelevant information would swamp the few nuggets of vital data.

Communication may take various forms but for science we really mean the imparting or exchanging of information or ideas. This might for example be in the shape of a poem, a song, a cartoon, a graph or story. If in the form of a graph, what type and which scale should be used? With a computer students can investigate all sorts of possibilities previously not accessible.

Recording like communicating, may take various forms but whereas the the latter is for a wider audience the former is more often for the individual themselves and is a stepping stone, as is observation, to attaining an end product. Very often that which is observed is recorded in the form of a table, an environment that is the same as that of a spreadsheet. If a computer is available the information could be entered directly onto the spreadsheet but that is not essential. The advantage of the spreadsheet here is that the shape of the table is already constructed. If then mathematical manipulations have to be carried out then there is no fear for the student. Assuming that the object of the investigation is not purely mathematical,then the calculations can be done for them.

Classifying objects and their organisation into sets is an exercise frequently used in mathematics, but it is also of fundamental importance to science, being used in a variety of situations, but particularly of importance in the identification of animals and plants.

Prediction can be made on the basis of a number of observations viewed as a whole. Discovering that they can be wrong in predicting is a vital element of a students learning experience. Science in schools today should provide an opportunity for open ended work, as in LOGO, where children can make predictions and then follow them through with their own ideas.

SPREADSHEETS AND SCIENCE

As part of a project concerned with voyages of discovery a teacher used the opportunity to get the class to investigate the scientific principles of floating and sinking. One group of children made different shaped boats from balsa wood and carried out timed trials to determine which shape enabled the boat to move faster through the water. The time for five runs for each shape were entered onto a spreadsheet as in fig.1. This was then used to calculate the averages, the fastest time and the slowest time for each. Their stopwatch recorded the time to a hundredth of a second and the measurements therefore had to be calculated to two decimal places. Could eight year olds have carried out these sorts of calculations without a spreadsheet?

RUNS	Control	Shape 1	Shape 2	Shape 3	Shape 4	Shape 5
1	7.63	4.73	3.93	3.78	6.91	4.82
2	7.38	4.26	4.80	4.32	5.68	5.94
3	7.36	8.77	4.79	4.59	7.65	5.90
4	8.88	3.73	4.88	4.08	6.51	5.00
5	8.47	4.49	3.76	3.89	7.39	4.24
Fastest time	7.36	3.73	3.76	3.78	5.68	4.24
Slowest time	8.88	8.71	4.88	4.59	7.65	5.94
Average time	7.944	5.196	4.432	4.132	6.828	5.18

Fig.1. Spreadsheet displaying results of boat experiment.

Having made observations of weather over a period of time a group of students may set the recordings out in the form of a table. If that were not the end point itself, apart from constructing a graph of perhaps one or two of the parameters, very little else would be done with this data. Access to a spreadsheet however, enables various calculations to be made automatically, thus avoiding the mathematical hang-ups that many students have, yet enabling them to get to grips with the object of the exercise. It also provides an opportunity for the data to be displayed in the appropriate graphical form. Only in this way, can meaningful comparisons and inferences be easily made .

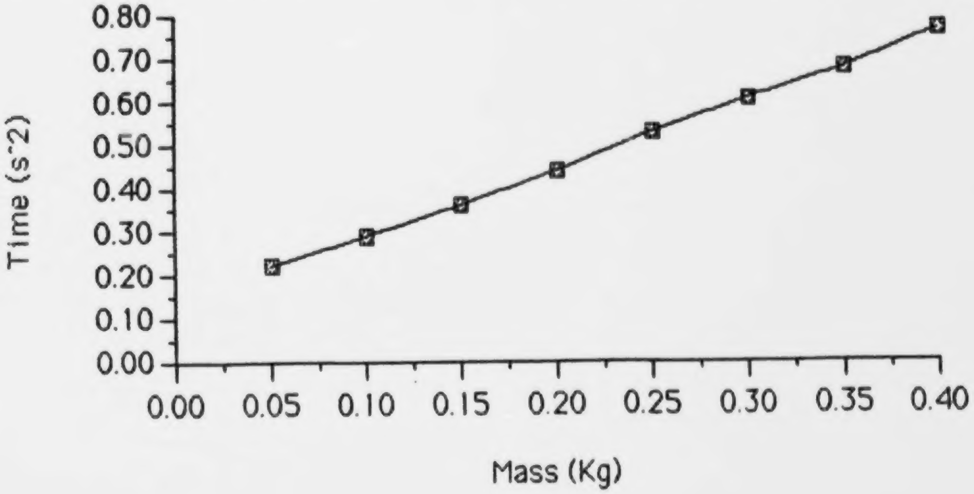
All the GCE A-level sciences involve students making observations, recording data, carrying out calculations and then plotting the results in a graphical form. Each of these processes are time consuming, although essential steps in an investigation or testing a hypothesis.

In one physics practical an investigation was carried out to find the ratio between Young's modulus and the modulus of rigidity for the material of a spiral spring. The procedure involved measuring the time period of 20 vertical oscillations (20T) with increasing masses. For each mass the time for one oscillation (T) is calculated and then this figure is squared. With a spreadsheet, it can be set up such that the results are produced as the figures are entered, as in fig.2.

	mass(kg)	20T(s)	T(s)	T^2 (s^2)
1	0.05	9.47	0.47	0.22
2	0.10	10.75	0.54	0.29
3	0.15	12.06	0.60	0.36
4	0.20	13.24	0.66	0.44
5	0.25	14.50	0.73	0.53
6	0.30	15.53	0.77	0.60
7	0.35	16.46	0.82	0.68
8	0.40	17.53	0.88	0.77

Fig.2. Spreadsheet from a Young's Modulus investigation.

The next step in the above investigation would be to plot the mass against T-squared and find the intercept on the ordinate axis. This figure would then be entered into a formula to complete the calculation of the ratio. An integrated package such as Jazz on an Apple Macintosh enables not only the spreadsheet to be used but the graph produced to scale as well. This can be seen below.



CONCLUSION

The numbers of computers in schools is increasing at a steady rate and providing there is a demand many will be used in science education. This however, will only come about if teachers are convinced that computers can enhance the processes of education. Spreadsheets are one of the few examples of software that can undoubtedly do this.

ELECTRONIC SPREADSHEET AND DATA BASE APPLICATIONS ACROSS THE CURRICULUM

George H.J. Porozny*

ABSTRACT

Computer application software (also called productivity and tool software) was developed by business, industry and the scientific disciplines to improve the speed, efficiency and accuracy of their work. These productivity tools have considerable potential for use in the field of education in all teaching discipline areas and at all instructional levels. Spreadsheet and data base software can assist students in analyzing information, identifying significant relationships in the information, and in drawing conclusions - activites that comprise a significant part of the current school curriculum. This paper identifies a number of specific applications where this software can be used in an instructional environment, to shorten student calculation time (with spreadsheets) and to teach students to manage large quantities of information more efficiently (with data bases). This would provide students with more opportunity and time for higher-level, critical-thinking experiences.

INTRODUCTION

In the information age, there is a growing need to equip students with the ability to use electronic technology. Processing information has become a basic human activity at work, in the community and at home. Educational institutions must equip future citizens with the ability to analyze data, to access, display, organize and manipulate information for the principal purpose of solving problems. By exploring and developing new applications and uses for computers and other technologies, society responds to the challenge identified by the widening gap between the complexity of world problems and the capacity of individuals and societies to solve them.

USING APPLICATION SOFTWARE IN THE CLASSROOM

Educators should be encouraged to investigate the potential of using spreadsheet and database systems in educational settings. The electronic spreadsheet is a modern version of the traditional large paper worksheet with rows and columns that teachers and students use to analyze and manipulate data. Modern databases are replacing large filing cabinets and index cards that were used to collect, store and access information. These tools allow educators to employ many of the traditional instructional procedures in new ways.

Vocationally, education has a major responsibility to acquaint students with new technology that touches their lives and to introduce them to the specific tools that will

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be used in future occupations. By integrating spreadsheet and data base knowledge into the classroom, students will have acquired additional preparation for using these productivity tools in society.

SPREADSHEET CHARACTERISTICS

Calculations that traditionally were done by hand or desk calculator and manually recorded in worksheet cells (the intersection of a row and column) can now be done electronically, making use of the microcomputer's superb calculation and recording abilities. In addition to adding, subtracting, dividing and multiplying, the spreadheet permits the user to analyze the information recorded, and to plan, project and predict future operations. These speculation exercises (called "What if?" scenarios) permit the user to see the effect of changing one spreadsheet value on all other related and dependent values in the spreadsheet. Automatic recalculation causes the new amounts to be immediately displayed on the screen.

TEACHING STUDENTS TO USE SPREADSHEET TECHNOLOGY

In introducing the spreadsheet to students, teachers should use a simple step-by-step approach, teaching key terms and concepts as they are arise. Instruction should begin with a blank spreadsheet, with the teacher "walking" the students through the first few simple problems while making the student comfortable with the software. The subject matter should be one that the students are familiar with and in which they have an interest. Exercises and activities that follow should be graded (sequential and cumulative) in nature, moving from the very simple to the more complex, and with each successive assignment a natural continuation of the previous one.

SPREADSHEET APPLICATIONS AND ACTIVITIES

A selected number of spreadsheet activities that imaginative teachers could adapt to various instructional levels and teaching areas, are listed below:

1. First year costs of owning an automobile - students identify and analyze automobile costs such as: initial purchase price, road licenses, petrol costs associated with estimated yearly mileage, car insurance rates, car service and repairs, mortage payments, etc
2. Cost of family weekly or monthly food bill - comparison shopping at three or four neighbourhood supermarkets
3. Budgeting for the school yearbook or other student publication - valuable costing exercise for determining a detailed itemized list of production costs, identifying the number of publications to print, etc
4. Community and school surveys - political, economic, social investigations
5. Vacation budgeting and planning for a family or club
6. Maintaining records for a school or community club recreational field day or sports meet

DATA BASE CHARACTERISTICS

Data base technology is an important tool in our modern, information-based society. Organizations rely increasingly on information to make informed business and economic decisions. There is an imperative need to collect, store and access increasingly large quantities of information and to have this information stored efficiently in small areas (floppy diskettes or hard disks) as compared to banks of four-drawer filing cabinets.

TEACHING STUDENTS TO USE DATA BASE TECHNOLOGY

The data base management tool has considerable potential in the educational area and represents a major untapped educational computer resource. Like the spreadsheet learning process, data base skills should be introduced to students in a logical manner and sequence, progressing from the simple to the more complex. Initially, students should be exposed to data files created by others. The content of the file should be information that the students already have some knowledge about, so that new learning is in the data base and its organization, not the information the file contains.

Throughout the lesson, the teacher should pause and point out the specific features of the data base system, define new terms used and be prepared to answer student questions. This implies, of course, that the teacher possesses a knowledge of the theory, concepts and procedures of data bases in general and has reviewed the material before introducing it to the class.

Once students are comfortable working with data bases, the teacher can then present them with a previously designed model or a template prepared specifically for the type of data base to be developed. With teacher assistance, the students can make plans for completing this data base. They must identify the sources of the data they wish to enter, proceed through the information-gathering stage and then enter the data they have collected. Depending upon the instructional level, the students can use a data base to answer teacher-prepared questions, requiring students to identify trends and relationships.

After students have had considerable practice in "fleshing in" a data base (recording information into a previously prepared data base template), they could continue to learn how to create their own data base from scratch. Considerable planning time should be spent in outlining the organization and purpose of the data base, the kinds of information to be retrieved, etc.

Using the data base tool in the classroom provides the student with many important educational experiences. Besides teaching students how information can be organized so that it can be accessed quickly and easily, they learn to develop searching strategies. They will appreciate the importance of defining a search question in a clear manner. By formulating questions about aspects of the problem, students learn to develop hypotheses which can be tested after data has been collected and interpreted. This is an opportunity for them to develop higher-level, critical-thinking skills, abilities important in an information-based society. The development of such higher order skills has always been an objective of the educational system; however, the need for such skills is even more important today, given the sheer volume of information to be evaluated and sifted through, in order to provide accurate, up-to-date information for decision making.

DATA BASE APPLICATIONS AND ACTIVITIES

Selected activities that teachers could use for introducing and incorporating data base technology into their classroom teaching are listed below:

1. Information about Canada's ten provinces and two territories. Students research sources and collect information for inclusion into a data base, with the opportunity to formulate questions, make comparisons and test hypotheses
2. Data base of part-time jobs in the community. Collect data on types of jobs, pay, day/evening/weekend hours, etc. Users search data base to determine the best places to apply for a position
3. Endangered bird or animal species. Students learn about endangered species as well as data base skills. Follow up could concentrate on how society can prevent extinction
4. Independence of countries (former colonies) after World War II. Collect and encorporate data on names of countries, independence date, size, population, major exports and imports, per capita income, system of government at independence and today, educational levels, life expectency and infant mortality rates, etc
5. Data base diary of class activities and events during school year - field trips, science fairs, art shows, tree planting activities, etc. Information can be used by classroom teacher and principal for school newsletters, publicity, etc

CONCLUSION

Information technology is changing curriculum content, the very nature of what students need to learn, as well as the manner in which instruction is being provided. Educators have an obligation to help their students prepare to become true knowledge workers - to improve the quality of education, by developing more efficient methods of working with information.

The effectiveness of the education received by students cannot be measured by the quantity of memorized content. Instead, these students will be judged by their ability to process information and from which they will make informed decisions. Understanding the concepts and having the ability to use productivity software as represented by the electronic spreadsheet and data base technology, will result in students having more time to devote to higher-level critical-thinking experiences.

POCO: Software Development for Computers in Education

Jef Moonen*

ABSTRACT

During the period 1984-1988 the Dutch government has stimulated the use of computers in education by executing the so-called Informatics Stimulation Plan (INSP). Within the context of this plan schools have been provided with hardware and a great effort has been done in relation to inservice training. Although the development of educational software was one other major activitity within the INSP, the provision of educational packages as a result of the INSP did not meet the expectations. There is the risk now, because of lack of educational software, that the previous efforts will remain sterile. Therefore, the Dutch government has recently decided to give a new major impulse towards the production of educational software. In this respect, a new project has started: the POCO project, meaning "Software Development for Computers in Education".

INTRODUCTION

The introduction of computers in education reflects the assumption that using computers will stimulate both the quality of education and the productivity of the educational system.

With this orientation, in 1984 the Dutch Ministry of Education started the Informatics Stimulation Plan (INSP) (ref 1), and indicated in this plan a set of priorities with respect to the introduction of computers into the educational system.

It has been established that a number of these activities have had a good start and have been quite successful (ref 1,2); for example, activities related to the provision of hardware to schools and to the development and delivery of inservice training of teachers. At the same time, however, it is clear that the amount of appropriate "courseware" available for schools is not at all adequate. It is possible that this courseware shortage may underlie some indications that the overall progress of the plan to implement computers as educational tools may be losing its momentum.

It is also apparent that the demands for such courseware are not being satisfied by the activities of commercial educational publishers. The results of a recent marketing research survey (ref 3) show that relatively high investments are needed for the development of such courseware and that the prospects that this kind of enterprise will become commercially attractive are very low. As a consequence, it is understandable that educational publishers are reluctant to enter this market.

In response to this situation the Dutch Ministry of Education has started the implementation of some interim actions, such as the POCO-project. These actions have as their aim the production and distribution of "relevant" courseware.

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"Relevant" courseware is defined in this context as teaching/learning material consisting of computer software and accompanying support material. Furthermore, the main focus is on material that can be used by teachers in a meaningful way during their regular teaching activities. Material that can be used with such frequency as to strengthen the teachers' perceptions that using such packages is an effective and efficient response to an educational need. Frequent use of appropriate courseware is perceived as 'the' major component in the process by which teachers become familiar with the use of computers.

The POCO-project is given the task of stimulating production of courseware to be used in existing curricula, and is focused toward primary, general secondary, and vocational (lower and middle) education. The courseware should also be useful in the activities that are planned for the preservice and inservice training of teachers. The project management of POCO is assigned to the Educational Computing Consortium BV - ECC (the privatised successor of the COI - Centre for Education and Information Technology at the University of Twente). The total budget of the project is 26 million guilders for a four year period: 1/12 for primary, 5/12 for general secondary and 6/12 for vocational education.

GLOBAL APPROACH

1. Timeline

The project will have a timeline of four years, split up in two cycles: 1/8/1987-1/1/89 and 1/1/89-1/9/91. Each cycle has a number of production phases. The first cycle includes at least one complete production phase. An evaluation of the project will be conducted by the Dutch government before the end of the first cycle. Based upon the result of this evaluation, the Dutch Minister of Education will decide if the project will continue through a second cycle.

2. Plan of Action

Each cycle of the project will involve the implementation of four processes, each essential in the production of courseware:

1. choosing priorities
2. formulating product descriptions
3. managing technical production
4. distributing the courseware.

The choice of priorities for the courseware to be produced is done at the beginning of each cycle. The other processes appear in each production phase.

2.1 Choosing Priorities

Priorities will be set taking into consideration the available budget, the most pressing needs of the educational sector, and the particular curriculum areas that are selected as the focuses for computer support. The POCO-management advises the Dutch Minister of Education about these choices. He will make the final decisions, based on this advice and input from other advisory bodies.

2.2 Formulating Product Descriptions

Following the selection of priorities for the project, the next phase is the development of product descriptions. These designs and specifications will be the basis for the subsequent technical production of the courseware.

2.3 Managing the Technical Production

The major body of activities within the first two phases of the project will be conducted by the 'Information and Evaluation' and 'Research and Development' divisions of ECC, supported by external consultants. For the technical production, proposals will be accepted from other parties interested in entering the project. Production contracts can also be given for the purpose of modifying existing products so that they better reflect the standards of the project and the needs of the Dutch educational situation.

The POCO-management will set up standards for the description and the production process as well as standards for the software itself; both of which will contribute to the "user-friendliness" of the courseware. With regard to these standards, the POCO-management will build upon work that has already been done related to methodological issues of courseware production within the activities of the INSP.

2.4 Distributing the Courseware

Final products will be delivered to educational publishers who will distribute the products through channels familiar to them and will charge the customers (the schools) a reasonable price for the products. Possible gains that flow back to the project will be used by ECC to start the development of other courseware packages. The project will hold the ownership of the courseware packages.

3. Amount of courseware to be produced

It is difficult to find a good measure to give a quantative indication of the use of software packages by pupils and teachers. The traditional 'measure' for quantifying the use of courseware, is the average time a pupil or teacher is interacting with a certain package. Measured by this approach, the POCO-project will deliver 600 hours of courseware (240 for secondary, 300 for vocational and 60 for primary). Split up over the two cycles: 150 hours for the first cycle 450 hours for the second cycle.

4. Role of the educational publishers

The educational publishers, with their specific knowledge of the educational market and the distribution of learning materials, will be asked to collaborate with the project management team from the beginning of the project. This in order to support them in overcoming their reluctance to enter this market and to stimulate their involvement in educational software production.

5. Evaluation

The POCO-project will be evaluated, right from the start. This evaluation will be the basis for continuing adjustment of the project. An evaluation plan has been set up and an external evaluator has been appointed. A number of interim-reports have already been published (ref 4). Independent of this 'internal' evaluation of the project, an external evaluation will be done by the Ministry of Education.

RESULTS

The result of the first phase, choosing priorities, are a process report (ref 5) and a number of 'white' papers (ref 6). In these papers a global framework is described from which a number of educational software packages can be developed (including accompanying written materials).
These results (ref 7) were presented to the Dutch Minister on December 1, 1987. After consultation by his advisors, the Minister has given permission for the project to proceed and to develop courseware for the following subject-areas.

1. Primary education (two priorities)

   - elementary reading: using the computer for remedial teaching, individualised instruction, differentiation in speed, level and kind of exercise
   - applied arithmetic: using the computer to stimulate mathematical thinking and problem solving in an applied context.

2. General secondary education (eight priorities)

   - a language-environment for learning Dutch: an integrated package for wordprocessing and database facilities to be used individually and in groups
   - a language-environment for learning French: see previous priority
   - a language environment for learning English: see previous priority
   - thematic subjects for learning English: to stimulate communication skills between students and to create test facilities
   - a database program for geography for information retrieval about problems of third world countries: the database contains numerical, textual and graphical information
   - software for functions and graphs: to be used as a demonstration tool in the mathematics class as well as for individual and groups use
   - software to solve equations in mathematics: remedial programs to help students to solve first and second degree algebraic equations
   - a measurement environment: to be used in the physics laboratory for registration purposes, data collection and data processing

3. Vocational education (eight priorities)

The vocational sector in Dutch education has a great number of different subsectors. In order to be able to present priorities which can have some impact in relation to the number of pupils to be involved, these subsectors have been combined by the POCO-management into three subsectors: the Economic-Administrative sector, the Technical sector and the sector for Service and Health education.

For the Economic-Administrative sector, the choice was mainly based upon the circumstance that computer use in this sector was not yet widespread. Three priorities have been chosen:
- keyboard skills
- using wordprocessing skills
- learning about administration on a conceptual level

For the Technical sector the following priorities were chosen:
- developing a toolbox to support measurement, interpretation and calculation within laboratory activities
- software to support exercises in applied mechanics and for demonstration purposes
- software to support the reading of technical drawings

For the sector of Service and Health education, the following priorities were chosen:
- a hospital information system
- software to support fashion drawings.

By the end of the year 1988, a significant amount of this courseware will be available. By that time, the POCO-project will start marketing activities to promote the use of the designs upon which these courseware packages have been built by external parties. For information, contact the project manager of the POCO-project: drs. C. Nagtegaal, Education Computing Consortium, PO Box 217, 7500 AE Enschede, The Netherlands, tel. (31-53-892190).

REFERENCES

1. K. van Deursen, The Introduction of Information Technology in the Dutch Educational system. In: T. Plomp, K van Deursen, J. Moonen (eds.), CAL for EUROPE, Proceedings of a Conference of the European Commission on The Development of Educational Software, Enschede, The Netherlands, 25-28 May, 1986. Amsterdam, North-Holland, 1987.

2. J. Moonen, Computer-Aided Learning: A Self-Destroying Prophecy? Paper presented at an Educational Research Workshop on Interactive Learning and New Technologies, organised by The Council of Europe, Eindhoven, 2-5 June 1987.

3. J.A.M. De Vos, F.T. Benders, Courseware voor het voetlicht. Utrecht, Groep Educatieve Uitgevers, 1987 (in Dutch).

4. B. Collis, POCO Evaluation Reports nr. 1,2,3. Enschede, ECC, 1987.

5. L. Bergers, I. Harmsen, B. van Muylwijk, De POCO-conferenties. Enschede, ECC, 1987 (in Dutch).

6. Divisie Research & Development, ECC, Prioriteitsstelling Beroepsonderwijs, Voortgezet Onderwijs, Basisonderwijs. Enschede, ECC, 1987 (in Dutch).

7. C. Nagtegaal, Prioriteiten-POCO. Advies en Verantwoording. Enschede, ECC, 1987 (in Dutch).

DELTA, AN OVERVIEW

J.C. BEASLEY

Introduction

The need for retraining and upgrading of skills is a requirement that many of us face. It has been estimated that the average working man or woman may need to be retrained up to four time during their working lifetime. One of the causes of this is the rapid pace of technological change and the increasing use of information technology which shortens product lifecycles and necessitates an upgrading of skills. The traditional concept of education being only for those in school or college can no longer hold true. Open and distance learning provide the flexibility to learn at a convenient time and place.

The Commission has recognised that educational technology can provide a valuable enhancement to open and distance learning. A large amount of research is being undertaken in the member states and we do not wish to replicate this. However experience shows that irrespective of their technical merits, unless projects can capitalise on the larger European market their chances of success economically are slim. A primary rational of DELTA is therefore to encourage work on a European level so that significant economies of scale are possible, similar to those available in North America.

DELTA takes a systems view

A central feature of DELTA is that it takes a systems view of learning technology. There is a plethora of equipment and systems but much of it is incompatible. Under DELTA we intend to support the establishment of standards which will increase the compatibility and hence the potential market for individual learning products.

Intercepting the future

An important aim of DELTA is that its R&D is to be incremental. It seeks to build on the work already achieved and that planned under other EEC programmes, most notably ESPRIT and RACE. Along with DRIVE (road safety) and AIM (medical informatics) it seeks to apply new and anticipated technologies in a specific area. DELTA is an R&D programme and it will be researching and developing tools for learning. DELTA will not seek the development of learning software, which is one of the aims of COMETT.

Three time - scales

In order to set realistic subtargets within the overall aims of the DELTA Programme three time-scales are envisaged: an exploratory Pilot Phase lasting 18 months to 1990 is planned to be the fore-runner of a two-phase main stage taking the programme of work first to 1995 and subsequently to the year 2000.

For the Pilot Phase a budget of 20M ECU's is being requested. This will enable a number of practical exploratory studies to be made which will point the way forward, and possibly a few pilot demonstrations.

Level II to 1995

In Level II DELTA will be seeking to take advantage of the ISDN (Integrated Services Digital Network) telecommunications infrastructure and advances in hardware and software such as better Artificial Intelligence, Image Processing and more powerful Personal Computers (32:64 bit, 100 Mbytes).

Level III to 2000

By Level III Broadband communications (being developed under RACE, for example) will enable personal video - phone tutoring to become a reality while the workstations used for learning will incorporate features such as 5th Generation Artificial Intelligence and Natural Languages Interfaces. Let us now look at the horizontal division of DELTA into five lines of action.

Action Line I - Learning System Reference Model

Action Line I will allow the optimisation of the use of Community resources by the means of a Learning System Reference Model. This Reference Model will also serve in the planning and management of the DELTA programme.

Within the model the 'actors' involved will be identified and their requirements and relationships specified.

Action Line II - Collaborative R&D on equipment and systems

Action Line II provides for the collaborative research and development of the equipment and systems required, both hardware and software. The planned work can be divided into five areas (a) the Learner Environment covering work on a training server, a learner expert system, a personal electronic library and an electronic notebook; (b) the Authoring Facility - a Software Workbench which will enable the author to construct a first run of the courseware. The product of the authoring facility will be a low fidelity version of the final product; this will then be passed on to (c) the Production Environment. This facility will be able to call upon high resolution still pictures and moving video, musical and sound effects as well as computer graphics. (d) the Tutoring and Monitoring facility will assist the tutor with, for example, the intelligent monitoring of performance while (e) Information Resource Management will provide an On-Line European Learning Resource Directory with Intelligent Information Accessing. The resource directory will contain information, textual, audio and pictorial which will be of assistance to the actors.

Action Line III - Testing and validation including SOFT

Action Line III comprises testing and validation, including the communications, an important constituent of which is "SOFT" - Satellite Based Open Facility for Testing, aimed at the use of satellites for learning, with the use of broadband communications. Other work within Action Line III includes an analysis of the adaption to ISDN, video-audio conferencing, an information and programme exchange scheme and the design and specification of a Satellite Educational Channel.

Action Line IV - Interoperability

Action Line IV has the objective of "interoperability" -the support of the participation of the learning interest in the ongoing work of standards and harmonisation. In order to achieve this standards relevant to learning will need to be identified and support provided for their following up.

Action Line V - Creation of favourable conditions

Action Line V seeks the creation of favourable conditions. The previous four Action Lines aim to improve the supply of equipment, software and systems for learning but action on the demand side is also required to reduce the cost to open learning of communications and the lowering of the regulatory and fiscal barriers that would otherwise lead to higher costs to the learner.

Details of the five Action Lines proposed are presented in tabular form in Annex 1.

Timetable of Pilot Phase

The Proposal for the Pilot Phase is currently (December '87) before the four relevant Parliamentary Committees. The main Committee concerned (Energy Research and Technology) seems likely to have voted on its Opinion by late January. This Opinion then has to be considered by the Parliament in Plenary session and then if adopted it would go to the Council of Ministers. Once approval has been granted by the Council a DELTA Management Committee would be formed, to consider the work programme and the call for proposals. A call for proposals could then be issued in the Official Journal around May next. The call would close in June. Evaluation of the proposals would then take place and contracts would be signed. This timetable may well prove optimistic - particularly if the Council and the Parliament do not agree in the first round. If so, the call could be postponed by several months.

Submission of proposals

As noted, once the work programme has been agreed by the DELTA Committee the way will be clear for a call for proposals. These must relate to the headings and subjects figuring in the final version of the Work Programme ie. as agreed by the DELTA Committee on the basis of the regulation adopted by the Parliament and Council. Prospective applicants can already be considering partners and possible proposals based on the Annex to the Draft DELTA Regulation, but such proposals cannot usefully be finalised until the call for proposals, under the work programme in its final form, is published in the Official Journal.

Half the cost of each project will be met by the Community. The Partners in each potential project must come from at least two different Community countries and one of them must be a commercial enterprise able and willing to make the 50% contribution. Universities and research organisations are normally fully reimbursed.

The research is to be pre-competitive in that it must relate to that stage of development where the partners can work together without affecting their ability to compete in the market place.

DELTA questionnaires

To assist potential applicants in finding suitable partners we have been circulating a brief questionnaire. This provides details of the name and address of each organisation and relevant contact and information on the type of organisation (Association, Academic, Commercial, Governmental etc.), area's of interest within the field of DELTA (Artificial Intelligence, Authoring, Communications, Courseware, Hardware, MMI, Pedagogy etc), and Subject Disciplines (Maths, Computing, Medicine etc). In addition there is space for a brief (50-100 word) description of the organisation and its work to date in the field of learning technology. To date (Jan 88) over 650 questionnaires have been returned. These have been compiled and photo-reduced into a volume that we have been sending out to all those who have completed and returned their form.

If you wish to respond in this way, please get in touch with us at DG XIII in Brussels - Tel. 236.07.57.

Annex 1

Action Lines

Action Line I
- Construction of a Learning System Reference Model to optimise resources

Action Line II
- (a) Learner Environment
  - Training Server
  - Learner Expert System
  - Personal Electronic Library
  - Electronic Notebook
- (b) Authoring Facility
  - Software Workbench
- (c) Production Environment
  - Multimedia integration
- (d) Tutoring and Monitoring
  - Tutoring Facility
  - Intelligent monitoring of performance
- (e) Information Resource Management
  - On-line european Learning Resource Directory
  - Intelligent Information Accessing

Action Line III

(a) Video-audio conferencing
(b) Information and programme exchange system
(c) Adaptation to ISDN
(d) SOFT operational plan
(e) Design and specification of a Satellite Educational Channel
(f) Controlled experimentaion via SOFT

Action Line IV

(a) Identification of standards relevant to learning
(b) Organisation of support for learning standards

Action Line V

(a) Fiscal Treatement
(b) Regulatory conditions
(c) Telecommunications policy
(d) Copyright and authors' policy.

James Powell, Chris Creed and Paul Newland
DIRT, Design Information Research Team, School of Architecture, Portsmouth Polytechnic

Tetramorphic Communication for Design

Abstract

Everybody is a designer, in a sense we each design ourselves. To give ourselves a viable world in which to inhabit, we use strategies that give the least perceived pollution, enabling us to ignore that which would be seen as bad. Our research to date in a wide range of fields has given us the belief that a fourfold of such least pollution producing strategies exist. For any technology to become truly enabling it should have the potential to provide a forum in which individuals with differing strategies can begin to comprehend and realise the value of these other perspectives upon the world - interactive videodisc is one technology we feel is entering this arena.

Communication with Ourselves

We all attempt to build models of our world which allow those experiences we have had to be understandable. Many times experiences may throw us into confusion, if this confusion is not overcome it leads to psychosis. With two fundamental protection systems at hand this is fortunately a rare event. In many cases, especially for those who find themselves in fear engendering environments, the most effective defense is rejection - the experience is cut from our memory. However, the more profitable defense to new experience is to learn by enlarging our model that makes our experiences accessible and understandable without fear. It seems a very natural inclination to become precious about the model we carry with us, after all it is analogous to our consciousness.

We read a book, let us for the moment conceive of this book as having its own consciousness or a least representing the consciousness of the author. The text presents a model, just like this paper is doing, each reader can either reject or absorb this model into her/his own model. Then, having read the book we find someone else who has read it also. We engage them in conversation - strange - though they accept the model the text presents, their interpretation is not like ours. Now we think, "But my model is right, it is me, my interpretation of the book must be the real truth - I'll try and absorb his/her model into mine to demonstrate I have the true interpretation."

We all do this, in fact it may certainly now appear that we are attempting to do the same thing in writing this paper. However, there are three of us writing this paper - it's rather difficult, therefore, to write a paper if each of us has a model we know is true. Certainly we can continually double bluff each other convincing one of us that we are pervading his model, but this seems an infinite waste of time.

Let us take another avenue and look at our imaginary book as a catalyst for communication. A device, which in demonstrating that many interpretations are possible, suggests that instead of perceiving other peoples' views as either wrong or right, but just different, in the end we realise others have different interpretations we ourselves can learn far more from. Until recently catalysts of communication have had limited ability in:-

1). attracting a large audience
2). allowing individuals to generate very noticeably different interpretations while remaining obvious to those individuals that each saw the same content.

For a technology to be perceived as enabling we feel it should demonstrate an evolution towards satisfying these two criteria, and so allow not only communication with ourselves, but communication with others.

Commuication Styles

Using two questionnaires of high theoretical standing and empirical validity, we analysed designers for their learning style (using the Kolb, 1976 Learning Style Inventory, LSI) and their interpersonal style (using the Leary, 1957 Interpersonal Check List, ICL). Our data and interpretations are presented elsewhere (Newland, Powell and Creed, 1981) and they led to a recognition that each individual could employ one of four sets of strategies, we realised that a tetramorphic approach to communication would be required to convey information. From one particular perspective, that pervaded by this team, a view of these four communication approaches is presented in fig. 1.

To catalyse communication and, therefore, understanding amongst these four strategic approaches - the ideal would be engendering sufficient confidence within individuals to allow them to use the most sophisticated

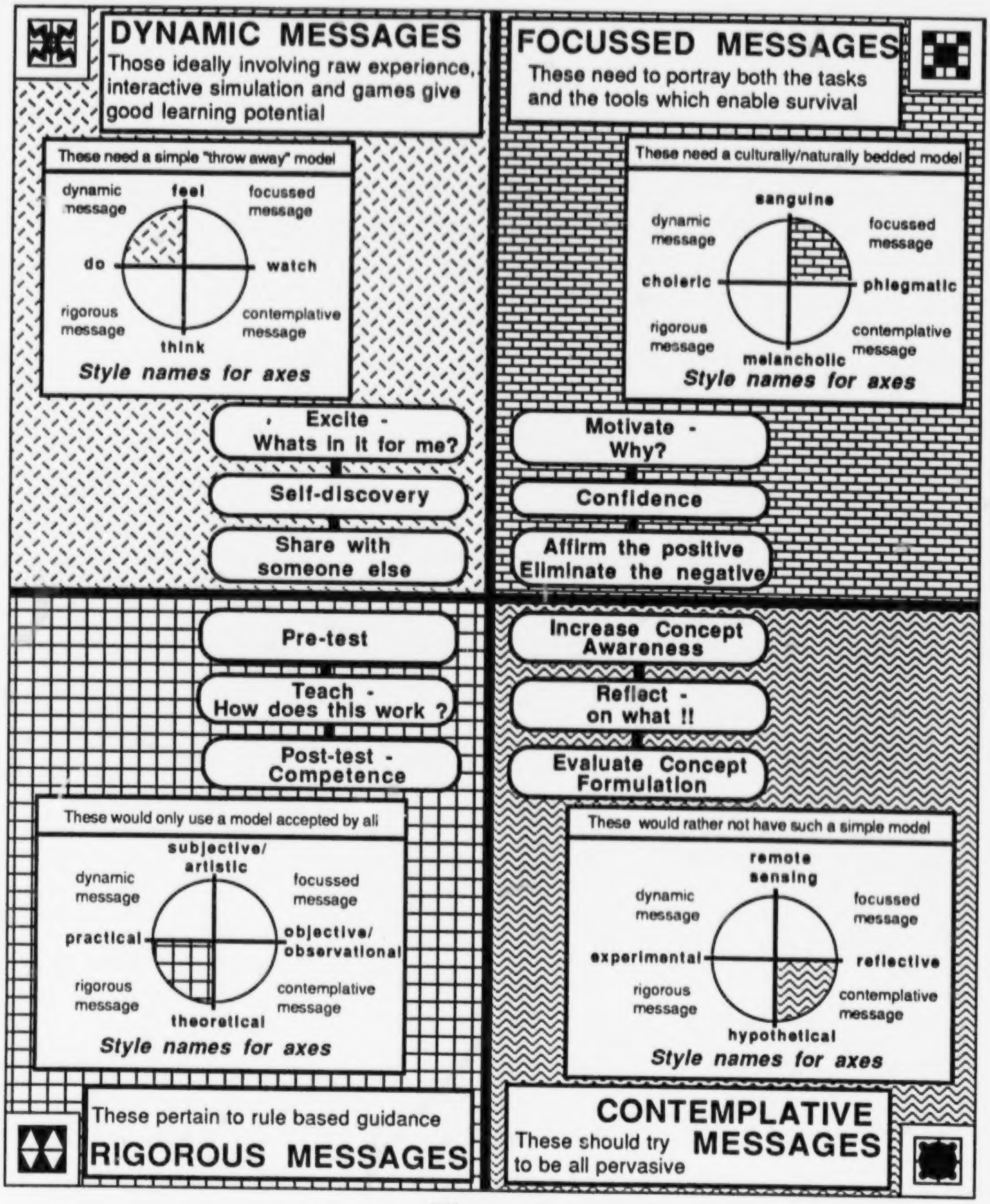
DYNAMIC MESSAGES
Those ideally involving raw experience, interactive simulation and games give good learning potential
These need a simple "throw away" model
dynamic message
feel
focussed message
do
watch
rigorous message
contemplative message
think
Style names for axes
Excite - Whats in it for me?
Self-discovery
Share with someone else
FOCUSSED MESSAGES
These need to portray both the tasks and the tools which enable survival
These need a culturally/naturally bedded model
sanguine
dynamic message
focussed message
choleric
phlegmatic
rigorous message
contemplative message
melancholic
Style names for axes
Motivate - Why?
Confidence
Affirm the positive Eliminate the negative
Pre-test
Teach - How does this work ?
Post-test - Competence
These would only use a model accepted by all
subjective/ artistic
dynamic message
focussed message
practical
objective/ observational
rigorous message
contemplative message
theoretical
Style names for axes
These pertain to rule based guidance
RIGOROUS MESSAGES
Increase Concept Awareness
Reflect - on what !!
Evaluate Concept Formulation
These would rather not have such a simple model
remote sensing
dynamic message
focussed message
experimental
reflective
rigorous message
contemplative message
hypothetical
Style names for axes
CONTEMPLATIVE MESSAGES
These should try to be all pervasive

Figure 1

Four Key Styles of Communication/Message

Shown in the Kolb/DIRT diagramatic convention communication device created by humanity that of interpersonal and multipersonal conversation. However, due to the defensive nature of individuals to protect their stance, individuals all too easily perceive other stances as polluted. A catalyst is required to reduce the level at which these defense barriers can be broken through. So far the best enabling technology we have found is that offered by the interactive videodisc.

Interactive Videodicsc for Tetramorphic Communication

To date we have used this medium to simulate an escape from a burning building - a communication message for those biased to the top left quadrant of our diagram. Specifically for designers, we have attempted to portray content material on why and how designers should be energy conscious in their designs from the perspective of each quadrant, using interactive videodisc as the medium for all the different messages required. Our project in progress is one that seeks to use the disc as an experience, one that demonstrates its potential for catalysing a context in which inter-strategy communication can be evolved.

> Now I a fourfold vision see,
> And a fourfold vision is given to me;
> 'Tis fourfold in my supreme delight
> And threefold in soft Beulah's night
> And twofold Always. May God us keep
> From Single vision and Newton's sleep!
>
> William Blake, 1802

References

Kolb, D.A. *The Learning Style Inventory Technical Manual* MacBer and Company, Boston, USA (1976)

Leary, T. *Interpersonal Diagnosis of Personality* Ronald Press Co., NY (1957)

Newland, P.M., Powell, J.A. and Creed, C *Understanding architectural designers' selective information handling* Design Studies Vol.8 no. 1 (1981)

INFORMATION REFERENCED TESTING - THE USE OF MCW-APM TEST SCORING TO ENHANCE THE CLASSROOM FORMATIVE EVALUATION PROCESS

J.E. Bruno*, J.B. Baxter**

ABSTRACT

Formative evaluation might be considered the centerpiece of the standard of care for the teaching profession. Measuring how students use information to indicate mastery of classroom instruction is a critical component of formative evaluation. This study summarizes research conducted at a large urban school site in the subject matter area of mathematics that utilized a computer based test scoring procedure called Modified Confidence Weighted-Admissible Probability Measurement (MCW-APM). The use of computer technology to both score multiple choice examinations using information based standards of mastery and generate individual student individual education plans (IEPs) is described in this study.

INTRODUCTION

The formative evaluation (FE) process is considered to be one of the major professional responsibilities of classroom teachers. It consists of a set of diagnostic-prescriptive procedures with appropriate administrator-teacher-student-parent feedback to simultaneously measure concepts of schooling (facts, skills, knowledge, information) as received by the student and instruction as delivered by the teacher (curriculum, materials, instructional resources). Its major function in the classroom is to enhance the learning of the child. Recently, computer technology has been focused on trying to stimulate the classroom formative evaluation process by producing clinical information to teachers to assist student learning. Coupled with this technology are new developments in scoring systems that are specifically designed to assess the actual information states of the student. One such scoring system is Modified Confidence Weighted - Admissible Probability Measurement (MCW-APM). The main objective of MCW-APM is to minimize distortions in multiple choice testing introduced by the need of the students to guess in order to maximize their score. With MCW-APM students are free to answer test item in less restricted response environments by using various letter options that indicate "I know," "I don't know," or "I am not sure." With this procedure points are only deducted for information known wrongly, partial credit is awarded for partial knowledge and no points are awarded or deducted for no information thus eliminating the need for a student to guess.

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INFORMATION REFERENCED TESTING AND MCW-APM SCORING

MCW-APM test scoring is based on a response triangle that spatially represents the student's subjective probability of a correct answer.

Each of the three corners or vertices of the triangle represents, to the student, 100% confidence in one of the three choices. Numerous students have demonstrated that three choice have no loss in reliability or test validity compared with four choice exams. In fact, when fixed total time is considered, studies have shown that three choices are considered optimal. These studies suggest that teachers may be wasting time and effort in developing four choice exams when three choices might actually be of higher quality. Three intermediate points, located at each of the three sides of the triangle, represent partial certainty or .25, .50, and .75 probabilities of confidence between two choices. One point located at the exact center of the triangle represents equal probabilities (A = .33, B = .33, C = .33) among the three choices (see figure one).

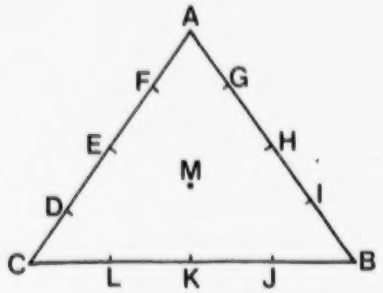

Figure One
The Response Triangle

The reward-penalty system associated with each letter on the triangle is used to insure that the conforming strategies of the test developer and the point maximizing strategy of the student are comparable. For purposes of simplicity the scoring system is approximated with dime or 10 cents units. A 100% confident and correct answer (fully informed) is worth 30 points, a .75 confidence and correct answer is worth 20 points and a .50 confidence and correct answer is worth 10 points (partially informed). An uninformed response (I don't know) or .33 for each choice (A, B, or C) is worth 0 points. A .25 confidence in an answer that is correct is worth -10 points and 100% confidence in an incorrect answer is worth -100 points. Thus, the ethical premise of MCW-APM is that students are only given credit for expressed confidence greater than or equal to .50 and correct, and only deducted points for expressed confidences less than or equal to .25 and correct, or 100% confidence and incorrect. No points are added or deducted for .33 confidence in each choice (an uninformed or "I don't know" response). The log of the confidence is used to obtain the actual MCW-APM or information referenced score.

In essence, MCW-APM not only corrects for guessing in its formulation but additionally corrects for confidence. Even though a student loses 100 points for each 100% confident and incorrect answer, the effect on the final score, percentage-wise, is the same as with a right-wrong (R-W) scoring system. In fact, percentage-wise, both scoring systems (MCW-APM) and (R-W) are congruent when students use only A-B-C (100% confident) responses.

In short, MCW-APM is a classroom evaluation procedure that nicely bridges the gap between the least restricted open response essay type exam (with benefits of partial credit) and the most restricted or fixed response forced choice exam (with benefits of objectivity and optical scan capabilities).

RESULTS: APPLICATIONS OF COMPUTER TECHNOLOGY AND IRT TESTING FOR FORMATIVE EVALUATION AND SUMMATIVE EVALUATION

In a recent study in a large urban school setting applying computer based MCW-APM test scoring with optical scanning, individual education plans (IEPs) were generated for each student to assist in the area of formative evaluation in mathematics. Table One depicts the computer generated IEP for the student. Notice that the IEP lists areas of misinformation, partial information and lack of information with instructional cross references. Students can then have these prescriptions "filled" in cooperative learning settings, computer or instructional labs, tutoring or teacher conferences.

```
               Students Misinformed Items on Examination

 Item (Information State)   Description-Instructional Cross Reference

 5    Misinformed    (skill)  MC59    Subtraction of Whole Numbers
                      (text)   Holt (grade) 5/ (pages) 62-63
 8    Misinformed             MC61    Multiplication of Whole Numbers
                               Holt 5/90-91
 10   Misinformed             MC61    Multiplication of Whole Numbers
                               Holt 5/90-91

 (etc. for rest of the misinformed test items)


      Students Uninformed (or left blank) Items on Examination

 Item (Information State)   Description-Instructional Cross-Reference

 4    Uninformed              MC59    Subtraction of Whole Numbers
                               Holt 5/522-55, 86-89
 9    Uninformed              MC61    Multiplication of Whole Numbers
                               Holt 5/92-93
 12   Uninformed              MC63    Division of Whole Numbers
                               Holt 5/110-111, 130-131, 134-135

 (etc. for rest of the uninformed items)

         Students Partially Informed Items on Examination

 (Computer generated print-out continues as above, for all information
 states.  All test items will be classified as to student information
 states)
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Table One - The Short Form IEP Analysis

The long form of the computer generated IEP is used by the teacher for detailed clinical analysis of student learning. It compares student performances on IRT based standards of mastery with class averages (see table two). Especially note the confidence index. This IRT statistic is the average confidence in correct information across all test items.

Teachers desiring selection score cutoffs for summative evaluations and/or letter grades can use this index as a measure of not only the recognition in the correct information but the confidence in that recognition.

Overall Information Base Assessment and Diagnosis

IRT Diagnosis	Student Performance	Class Average
Information Score (MCW-APM Score)	0.58	0.67
Summative IRT Evaluation		
Av. Confidence in Correct Ans. Across Items -	22	
IRT Assessment and Instr. Strategy -	Near Misinformed/Re-educate	
IRT Approximate Letter Grade -	D	
Information Use (% correct when 100% confident)	0.44	0.64
Expectation Score (Conversion MCW-APM to R-W)	0.25	0.54
IRT Formative Evaluation Assessment for MCW-APM Responses		
Percent Certainty (100% Confident Responses)	0.56	0.82
Percent Correct Certainty (Correct Response ABC)	0.25	0.53
Percent Uncertainty (DEFGHIJKLM Response)	0.43	0.17
Percent Uninformed (M Responses)	0.40	0.02
Percent Blank (No Response)	0.00	0.00
Assessment For R-W Responses		
Percent Correct (R-W)	0.46	0.64
Percent Incorrect (R-W)	0.53	0.35
Corrected R-W (RWC)	0.20	0.46

Table Two - The Detailed IEP Analysis

It is important to note that MCW-APM test scoring, unlike R-W scoring, is sensitive over the entire range of student response confidence levels (100% confident and correct to 100% confident and incorrect).

SUMMARY AND CONCLUSIONS

In essence, IRT test scoring using MCW-APM place strong incentives on students to present or "admit" an honest display of their information in the less restrictive answering environment ("I am sure," "I don't know," or "I am not sure") while maintaining objectivity and optical scan capabilities.

In summary, the use of computer technology with an optically scannable confidence weighted type of test scoring such as MCW-APM can significantly enhance the classroom formative evaluation process. More importantly, clinical diagnostic information such as the type generated by MCW-APM can significantly assist teachers in their understanding how students have mastered the material or information presented in class based on information referenced standards of mastery.

THE LOGICREATIVE APPROACH: HOW TO TEACH LOGO SUCCESSFULLY

Patricia Ann Brock*

ABSTRACT

Why isn't LOGO succeeding? There are two reasons: Firstly, many teachers don't understand the educational potential of LOGO. In order to completely understand LOGO, an approach needed to be designed to not only teach the underlying principles and processes but also to develop a positive attitude towards the program and its implementation in the classroom.

Secondly, an approach needed to be developed that would encourage the learner to succeed in a traditional mode then progress to a more discovery, inquiry mode.

This paper presents the approach that successfully teaches LOGO: The Logicreative Approach defined as a logical, tutorial approach that incorporates creativity and conversely, a creative approach that incorporates logic.

A pilot program instituted in 1987 at the Rider College School of Education (and replicated with education students in Rutgers University) successfully instructs future teachers in the value and skills of LOGO.

INTRODUCTION

Why did LOGO fail in so many school settings? Criticisms mounted and lukewarm success stories were reported. The problems seem to lie with a misunderstanding of LOGO as to what it is philosophically and where it fits in the classroom plus a lack of properly trained teachers.

Historically, many of our teachers were educated in a traditional setting. In order to teach LOGO, LOGO must be adjusted to adapt to the needs and learning styles of the educator involved. The average teacher does not have hours of free time to experiment and explore LOGO as Papert advises, so an efficient method had to be developed.

A creative, free approach to LOGO caused frustration to many students. A positive attitude was often difficult to achieve. If students were feeling uncomfortable with the experience, how could they see any value in the philosophy or any usefulness for LOGO's role in a traditional classroom curriculum?

Historically, factual recitation has been a prime indication of learning. If norm referenced tests measure the ability to memorize, comprehend and apply facts, how can an educator measure the progress of the higher level thinking skills which are logical, creative or evaluative thought processes?

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The answer is simple: by using LOGO. For nearly two decades Seymour Papert's language for exploration encouraged students to experiment, investigate and create in a computer microworld. No educator can seriously argue against the benefits of the underlying assumptions of the LOGO philosophy with its Piagetian orientation.

METHODOLOGICAL APPROACH

Initially each student or pair of students (100 students) received tutorial guides entitled "LOGO Labs" to be completed in the computer labs. The completed lessons were discussed and reflected upon in a whole group situation thus, encouraging a feeling of esprit de corps in the new learning experience. Students were made aware of the higher level thinking skills they were utilizing and how these experiences could be implemented in the teaching setting. Emphasis focused upon the interdisciplinary aspect of LOGO and its relationship to problem solving in real life situations. Each lesson presented consisted of the following three stages:

1. The Introductory Stage: a limited number of terms were defined and illustrated to provide a familiarity with the specialized language of LOGO.
2. The Exploratory Stage: simple models were replicated by the students from terms previously presented providing a sense of terminology mastery as students learned to understand LOGO through experiencing successful lessons.
3. The Discovery Stage: incorporated both the students' understanding of the terminology based on the introductory discussion plus the experience as students created original programs.

At the completion of each LOGO Lab, students are required to provide reflective comments regarding what they learned about LOGO and themselves. This diary commentary provides the student and the teacher with an informal evaluative, cumulative record of problems, concerns and LOGO experential and attitudinal development.

As the lessons progressed, students followed the three stage approach adding to their knowledge base of LOGO and confidently creating more complex original programs. Although not purely the nonsequential Papert-type approach, this systematic method helped ease student frustration of learning a new programming language while they were offered the opportunity to explore, increase their curiosity and confidently accept the challenge to create.

However, if the students (or teacher) would rather provide a less sequenced approach, each lesson is designed as a separate, independent "Module" that can be presented according to the need or interest of the learners involved. Thus, a more Papert-style approach can be accommodated.

In both approaches, students learned not only Turtlegraphics, but Interactive Programming through text and music procedures. Once the LOGO Lab Modules were completed, the students were prepared to design original programs independently or with partners.

INTERDISCIPLINARY APPROACH

To further illustrate the interdisciplinary implementation of LOGO, the students are required to follow the scientific method to complete their original programs. The following components are required:

1. State the Problem: determine which program to create.
2. Gather Data: review what they have learned in the LOGO Labs, exploratory experiences and model designs.
3. Formulate a Hypothesis: illustrate on paper how the completed assignment will appear and/or sound.
4. Experiment, Organize and Analyze Data: develop their assignments using class time and scheduled lab session times with student supervisors who have experienced LOGO during a prior semester.
5. Formulate Conclusions: develop successful programs that can be logically replicated if the same procedures are utilized.
6. Verify, Reject or Modify the Hypothesis: present their final products to the class and discuss any modifications that were made to the original hypotheses. Further recommendations are made as to possible extensions of the projects or new applications for product designs.

With student approvals, copies of the programs are filed and used as models for future students. The models serve a twofold purpose: Firstly, as creative examples of LOGO versatility and secondly, as motivational examples to illustrate what can be done by students in the same learning experiences - a confidence builder.

RESULTS

In conclusion, education students using the Logicreative Approach have developed a positive attitude towards LOGO, confidence in their LOGO abilities and a realization in the value and applicability of LOGO in the traditional classroom. With this initial structured approach, students and teachers can utilize the comfortable, traditional LOGO learning experience to build self-confidence in controlling the computer while developing their logic and creative skills. The discovery and exploratory challenge of LOGO and problem solving will be more confidently accepted as students and teachers continue successfully along the learning continuum from traditional to discovery approaches.

MICRO-COMPUTERS AND THE SOCIAL SUBJECTS IN SCOTTISH SECONDARY SCHOOLS

J. R. G. Jennings*

ABSTRACT

A feasibility study and a project (1983-88) has identified flexible suites of software that are appropriate in social subjects teaching for S1/S2. This software is currently being piloted in seven secondary schools in Scotland. This paper is therefore an interim report on a current project.

The project has been eclectic in its use of software, selecting whatever seemed most appropriate to the topics being taught in the different schools. Hence a wide range of software has been used from many different sources. Teachers and pupils have responded well, showing little or no trepidation in using the software effectively in most cases. The issues that are raised and that constitute the barriers to an effective use of micros across the curriculum are hardware and software availability and accessibility.

The project is now starting to look at the implications of 16/32 bit micros becoming available to social subjects departments. To gain a real advantage from these micros requires a fairly radical rethink on software provision in schools.

INTRODUCTION

The social subjects (geography, history, modern studies and economics) have been a focus for papers, books, projects and software production from the earliest days of main frames and "batch processing". Despite all this work, both in England/Wales and separately in Scotland, fully integrated, run of the mill use of the micro is still sporadic and frequently related to computer enthusiasts[1] rather than to subject enthusiasts. Many very able and effective social subjects teachers do not yet see the micro as essential in their work. The work of the project is another attempt to break out from the enthusiasts redoubt to the general body of social subjects teachers and pupils.

DEVELOPMENT

A close link between this project and the much larger Consultative Committee for the Curriculum S1/S2 Development Programme was seen as having mutual advantages. This work was a collaborative approach between the separate social subjects to curriculum design and its delivery in first and second

[1] *HMI (Scotland) "Learning and Teaching in Scottish Secondary Schools: the Use of Microcomputers" HMSO 1987.*

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years of the secondary schooling (S1/S2). There was to be an emphasis on innovation in teaching and learning, with emphasis on pupil involvement and a process based approach. At least a dozen pilot schools would be involved initially with a cascade model of subsequent dissemination. The collaborative approach, innovation in teaching and learning and a pupil focus, suited the micro project admirably. The hope was to be able to use a small section of the C.C.C. first and second line pilot schools for our work.

In the event, Development Programme piloting ran into considerable difficulties because of teachers' action and this postponed any pilot work on the micro project for two years until the dispute was resolved in June 1987. The enforced delay of just over two years was not time entirely wasted. Unable to approach teachers, the project directors held a two-day conference[2] of curriculum development officers, HMI, college of education and advisers in 1985 at the end of the Feasibility Study, to identify:

i) the requirements of the social subjects in both micro hardware and software

ii) themes and strategies concerned with the effective use of micros common to all social subjects.

This was followed by fairly extensive discussions with personnel involved with micros in the social subjects, including colleagues in England and Wales. A good deal of time was also spent in evaluating software and developing the idea of flexible suites of software. It became apparent that, while many curriculum developers, official publications and reports stressed the need for more use of micros across the curriculum, and in social subjects in particular, few, if any, clearly indicated how much or the variety that was minimally acceptable, optimal or excessive. The project has focussed on this question of a balanced and varied use of software across a major area of the curriculum over the first two years of secondary schooling. The objectives are:

i) to enhance the teaching and learning of the social subjects

ii) to introduce the pupils in a relevant context to varied types of software that can assist learning in areas that are difficult by other means e.g. data handling, simulation, environment creation.

The project directors decided against the writing of software because:

i) there was a reasonable quantity, although of variable quality, available

ii) it is very time consuming for often mediocre results

iii) of the need to get schools (and pupils) using effectively what was already there.

iv) they wished to avoid any proprietary attitude to software used by schools. Many, if not most, projects have been concerned with introducing and developing their own software, this can lead to tunnel vision and over enthusiastic claims for specific programs.

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[2] *Jennings, J R G, Munro, R K "The Way Forward" Aberdeen College of Education.*

While no software has been, or is, to be written, what has proved necessary is the production of data files. In response to pilot schools' demands, files on northern and north-east Scottish place names, population and socio-economic data for the same areas, Japan and the World have been supplied for use with the ITV program KEY. The production and distribution of data files relevant to the secondary social subjects curriculum is a pressing need that only now is beginning to be met[3].

THE PILOTING

This has finally got underway from August 1987, initially involving five schools with two more to join as soon as it could be arranged. This was regarded as the maximum that could be handled by the project directors who only have about one day a week each for visiting the schools. The criteria for selection were:

i) at least two out of the possible three social subjects departments being willing to incorporate software into their programs

ii) ready access to at least one BBC micro with disc drive

iii) schools in which the social subjects departments had good relations with each other

iv) social subjects departments already using, or about to use, pupil centred/resource based learning.

Previous work with micros, being a micro enthusiast or possessing a sizeable software library were not criteria. Even with the relatively modest criteria used, the number of schools from which to choose within a 100 mile radius is not large.

Each of the participating schools was visited in June to obtain details of their S1/S2 social subjects curricula. One of the important principles was to incorporate existing, readily available software into the existing topics. The micro must be the servant which enhances the teaching and learning, not the dictator of it. A second principle that follows from this is that, within a topic, the occasions on which the micro is used may be frequent, sparse or not at all, depending on what is being taught and the percieved relevance of any software available.

The actual use of software with classes has proceeded from August/September in an irregular, but natural and relevant manner in all but one of the first five schools. The fifth one, although in many ways having the most favourable set up, both in terms of facilities and with an individualised resource based integrated social subjects syllabus, could not get ready access to a micro before Christmas. The school was well endowed with micros, but they were all committed, principally to computer studies.

As each piece of software is used, the teacher completes an evaluation form which is returned to one or other project director. The using of relevant software, selected by the school in consultation with a project director, will continue throughout the session 1987/88 with the

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3. *Information Technology: ITV Schools 1988. Associated data files for Key.*

possibility of some additional material being used in the autumn of 1988. An initial report will be available by September 1988 and the final report in December 1988.

INTERIM RESULTS AND CONCLUSIONS JANUARY 1988

Thirteen programs have been used in four schools since September, including accessing data files. In addition to working with E.S.R.C. Census (Scotland) File and three specially prepared files for Key, schools have used simulations (Shallow Hill, Fletcher's Castle), a tutorial program (Into the Unknown), modelling (British Farm Model, Windmill Game), drill and practice (Introducing Map Skills and Micro-map). In addition, teachers have reviewed a number of programs with the intention of using them between January and March 1988.

The first result is that the teachers have a much clearer idea of what is available and how particular software might be used. They also appreciate that there is variety in software and that different learning situations can call for different types of software. Using software has not presented problems to either teachers or pupils. Pupil confidence, even with less able children, has been a very noticeable feature. Could it be that we have over emphasised the computer/user interface problem and imagined more problems than actually exist?

The teachers' responses through the evaluation forms and by personal contact have been very encouraging. The software used has fitted in well with existing work and the development of support materials, whilst necessary, is not seen as a major problem. The comment that appears in virtually every return is the value of the software in promoting genuine discussion among pupils.

A problem that has been encountered is hardware availability. The development of computer studies as an examination subject is making the problem more acute despite more micros in individual schools. Significantly the school that did not have a computer studies department was the only one where the social subjects classes have been using a network (Econet) because the computer laboratory is available. The school that could not make the anticipated start has a BBC computer laboratory, 16 bit machines and principal teacher of computing with a full timetable.[4]

A second problem is assessing software in advance of purchase. The recently introduced inspection service of at least one software house is most welcome. Although software has fallen in price recently and is very cheap relative to the work involved and the likely sales, it is still expensive relative to the budgets of the social subjects departments of the pilot schools. They had acquired software by various means, in some cases over a fairly lengthy period, but it could not be said in any school or individual department to form a coherent pattern. In terms of software these schools are probably better off than most in both quantity of software and the basis on which it has been selected. In comparison with videos and slide sets, micro software availability is very primitive with no immediate signs of improvement. Education Authority Library services for schools to borrow software seems the only way forward from the present situation[5]. For the purposes of the project, the issue has been side-stepped by the simple expedient of buying additional software for the pilot schools.

4. *National In-Service Course - Information Technology, St. Andrew's College 1987, for reinforcing case studies.*

5. *HMI (Scotland) ibid pp 16-34.*

BEYOND THE 8 BIT MICRO

Stage 1 of the project is concerned with achieving momentum in the social subjects using the BBC variants. This is coming close to "bolting stable doors" because the 16/32 bit micros are now very much with us at prices sometimes below those of BBCs. A development project must look to the future and attempt to map a route for social subjects departments into the 1990's[6]. Therefore, Stage II of the project is beginning to work in this area. The principles remain the same as those of Stage I, but there is the additional one of seeing if the great power, flexibility and memory of the 16/32 bit micros can be fully exploited for the benefit of the social subjects in secondary schools.

With this in mind, there are considerable reservations over the re-writing of 8 bit software, some with its origins in pre-micro days, for the Nimbus or Archimedes. The main task is to see how software specifically for these machines can be adapted to school use. The appearance of 16/32 bit makes a break with the past, the days of "cottage industry" software[7] should be over. The self taught, or short course, teacher programmer, working in their own time, is unlikely to lead to effective software in the future. The new machines surely require fully professional software to make effective use of their power. The disappearance of the semi-amateur programmer also means the end of the subject/topic specific program. The future lies with the adopting and adapting of commercial business software to educational purposes.

Tackling this problem is the Stage II focus and is now getting under way with target of completion in Spring 1990.

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6. *Fox, P. Tapsfield, A. "The Role and Value of New Technology in Geography", Geographical Association 1985.*

7. *Self, J. "Microcomputers in Education", Harvester 1985.*

DESIGNING USABLE SOFTWARE FOR SPECIAL NEEDS

R.J. Collins* and J.R. Hegarty*

INTRODUCTION

Too many lists of evaluation criteria for educational software exist to make it practical to discuss them in detail here, but it may be asserted that the points made within many lists emphasise two general groups of criteria - those dealing with 'Functional' aspects and those dealing with 'Educational' aspects of design (Collins 1987). By 'Functional' aspects we would refer to the 'mechanical' aspects of computer software - is it 'bug' free, Will it accept unusual inputs and still give meaningful results or error messages? Ultimately, does it perform to its specification? By 'Educational' aspects we would refer to the ease with which the system may be used as an effective means of teaching - is the content meaningful and correctly presented? Has it got a place in the existing curriculum?

While it is true that criteria that fall into these categories are important they are certainly not the only criteria by which educational software may be judged. Perhaps, more importantly, regardless of evaluation forms or even of training they are not necessarily the criteria that teachers use to evaluate software for their own use (Preece and Jones 1985). The relative emphasis on these types of criteria reflects the orientation of those people who are likely to produce evaluation check-lists for consumption by others, namely computer programmers and producers of software on the one hand and educational technologists and 'theoreticians' on the other.

This paper concerns the broadening of categories of design and evaluation criteria for educational software to include personal and affective aspects, which may ultimately be the true criteria on which decisions to use or not to use software may be based. The suggestion is made that by making personal and affective criteria explicit and placing due emphasis on these aspects with respect to overall programme design, educational technologists may aid the implementation of software which fulfils their own criteria of 'Functional' and 'Educational' value.

THE AIMS OF SOFTWARE AND OUR OWN CRITERIA

In our own research we have sought to develop a series of explicit design criteria as an aid (or at least as a point for discussion) for others who would produce educational software. Our principal emphasis has been on producing software for adults and teenagers who have learning difficulties and while particular items of software would not necessarily be appropriate to the main-stream classroom, we feel that the guidelines and emphasis developed are of general enough applicability to make them useful to main-stream educational software designers. As will be described, our set of criteria have developed over a period of years to include aspects of design that we hope will aid the implementation and

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actual use of software by catering to the personal and individual needs of teachers and carers. Criteria have been developed by iteratively specifying sample criteria, producing software and then evaluating software with particular reference to the effect that specific criteria have had on the actual practical use of software within educational settings (for example see Hegarty and Collins 1986). Out general requirements on software are that it should be:

1. age appropriate, which we have felt to be of particular importance concerning the use of educational software with adults who have learning difficulties - a group which has been poorly catered for until recently.
2. self adjusting, that is to be 'reactive' to the players level of ability and needs as a learner (After Ager 1986).
3. capable of collecting and presenting accurate records of student's interactions with the programme.
4. design to regard students as active learners rather than place them in a passive role.

As an example of how these loose requirements have been refined into criteria which accommodate the personal, affective aspects of individual users, we will describe how one particular theme - that of accurate record keeping and presentation - has progressed through three different software developments.

RECORD KEEPING WITHIN EDUCATIONAL SOFTWARE

We have had very specific and, we believe, justifiably important reasons for placing a strong emphasis on record keeping facilities within our software. We believe these facilities should be included:

1. because they aid teachers in making intelligent decisions about the use of the programmes with individual students.
2. because they help with the requirement placed on carers and teachers to produce individual educational plans for students with learning disabilities and to monitor progress with respect to these plans.
3. because they facilitate formative evaluation of the programme itself and thus aid future software developments.
4. because they facilitate external validation of the progress students make on the computer. Much progress on educational software is invisable due to the failure of software to produce tanigble results - unlike work with pencils, pens, paints and paper!
5. because they provide a research tool to help investigate individual learning and teaching by the computer.

The three suites of software described here have each been designed for a different 'client' group within special education - catering for a spectrum of primary users (i.e. students) but a reasonably similar group of secondary users (i.e. teachers). Briefly the three items of software are:

1. "Mr. Ugh" - an 'arcade' game designed for use by severely handicapped students to encourage co-ordination, 'tracking and following', active decision making and (possibly most importantly) as a leisure activity. The task involves stearing a small 'space-invader' character around the screen to make contact with a large ugly face, "Mr. Ugh". The game models a game of 'tag' and as the student progresses through the levels the game becomes more difficult in a variety of ways - "Mr. Ugh" gets smaller, he starts to run away and a simple maze appears.

2. "Box Word" - a content free, early reading skills programme designed to help develop strategies for recognising individual words. This programme was designed specifically for a group of mildly handicapped school leavers.

3. "The Report Writer" - this is a utility programme for use by teachers working with profoundly handicapped students. The software is designed for use with a device which is becoming quite popular in special care units catering for profoundly handicapped students called a 'Pethna'. The 'Pethna' consists of a variety of input switches each designed to teach students different manual skills, and a 'reward' unit containing a tape cassette player that plays loud music when the student operates the switch correctly.

These programmes also represent a progression through time with "Mr.Ugh" being the first item of software produced by us and "The Report Writer" being the most recent. Although of varying complexity with respect to other aspects of the design (due to the function of the programmes) we believe that they also represent a step-wise refinement in terms of their facilities for recording and presenting data AND THE EASE WITH WHICH THESE FACILITIES MAY BE USED EFFECTIVELY BY TEACHERS.

Limited space prevents us from describing the complete studies involving the development and evaluation of this softwart but we will now summarise the differences in the record keeping and presentation functions for each of these programmes and the resulting comments and criticisms that emerged in each of the evaluation phases.

1. "Mr. Ugh" - all of the data collected and presented within "Mr.Ugh" is in the form of graphs and charts. Two graphs plotted the 'level of play' against time and the actual time to hit the target at each level (the game is divided into 15 levels of difficulty which students move through depending on success at any particular level). One chart plots the way in which the controlling joystick is used by the student but will not be described further here because of its specificity to "Mr. Ugh" and other 'arcade games'.

   During the formative evaluation and re-writing phase of "Mr. Ugh" two other graphs were removed from the system. The two graphs remained unused by psychologists and teachers alike when the system was used. The first graph showed the initial distance between the user's 'invader' and the target "Mr. Ugh" which is set randomly within the programme. The second graph used this information and the 'time to hit target' data to produce a compound graph of 'homing velocity' (velocity = distance/time). Although this graph was greatly favoured by the physicist in the group (R.C.) as the best measure of student performance at any given level, it was rejected by all other members of the formative evaluation group as being essentially meaningless. The group involved found it impossible to relate 'homing velocity' with 'what the student had actually been doing' but found the retained graphs comprehensible and quite straightforward (Collins and Hegarty 1986).

(2) "Box Word" - This programme was improved over "Mr. Ugh" with respect to the fact that when producing printed graphs of student progress it did so in the form of a report form for the teacher to fill in with other personal data not recorded by the computer. This was thought to be important because the use of "Mr. Ugh" had been greatly hampered by the inability of teachers (and student psychologists!) to manage the large amount of data being produced. Common errors were to omit recording which student the data was for, what the date was and other observational data that could give an insight into the form of the results. To combat this the report form included titled spaces for each of these items of information so that as soon as graphs were printed out the teacher in charge was prompted to record the information (Hegarty and Collins 1987)

(3) "The Report Writer" - Developing on from both of these programmes this system was completely geared towards creating and presenting reports. The problem with "Box Word" was that, although the system allowed the user to collect all the information to present useful reports of student progress, this was rarely doen in practice, in fact, recorded data seemed to be used at a very 'intuitive' level. The whole design philosophy of this programme developed from the belief that collecting information about student progress is not enough, the data needs to be reviewed and acted upon. Within "The Report Writer" is contained a small 'electronic note-pad' for the teachers written comments and notes and must be filled in before data can be presented in the form of a report. All information, both computer collected data and notes, are saved to a floppy disk automatically so that no imperitive commands are required from the teacher. Also important is the fact that basic data is displayed in a variety of formats that accommodate different classes of users and individual preference.

CONCLUSION

A brief list of criteria for data display within educational software.

Results from the three developments outlined above suggest that a reasonable set of design criteria for data display in educational software are as follows:

1. Graph data should be presented in the most familiar format that is aooropriate.

2. The user should have choice over the format of the display although simple 'default' options should be available.

3. Reference manuals should provide an explicit method for interpretting data with relevant examples.

4. Paper copies of all data should be available in the form of a

'report' containing all relevant student identifying data on the page.

5. There should be the facility for including teachers' observations and comments on the report form - preverably the software should encourage the use of such facilities.

6. Experimentation with our systems has suggested that graphs should be drawn to a constant scale rather than being 'auto-scaled' as this aids interpretation by staff with limited experience of reading graphs and facilitates comparison over a number of sessions.

7. As well as this, standard good practice concerning the labelling and titling of graphs and the ticking of axis should be observed.

We would encourage other educational software producers to regard these criteria as guidelines and to refine them in the light of their own evaluative research.

REFERENCES

1. A. Ager, Performance contoured programming: A structure for microcomputer based teaching of individuals with severe learning disabilities. Programmed Learning and Educ. Technol., 23,(2) pp. 130 - 135 (1986)

2. R.J. Collins and J.R. Hegarty, "Mr. Ugh" - A game for everybody. In: The Computer as an Aid for those with Special Needs. Proceedings of the 4th ACTIVE Conference, University of Sheffield. (1986)

3. J.R. Hegarty and R.J. Collins, Box-Word and List Ed.: a case study in designing software for adults with Special Educational Needs. Programmed Learning and Educ. Technol.,24,(3) pp. 221-229.

4. R.J. Collins Computer Applications to Special Education. Ph. Thesis - In Press.

THE DEVELOPMENT AND USER ACCEPTANCE OF A MICROCOMPUTER-BASED CAMPUS-WIDE ELECTRONIC INFORMATION SYSTEM

T. J. Foley, K. R. Weiner [1]

ABSTRACT

The recent expansion of computing resources at colleges and universities has encouraged a decentralized approach to providing computer resources. This is most evident in the widespread proliferation of microcomputers on campus. One way to maximize the tremendous investment in hardware and software caused by this decentralization is to connect all the resources using networking technology. This paper is a brief status report on a project at Lehigh University utilizing low-cost personal computers as primary workstations to a campus-wide information system. The major objective of this project is to provide the campus with computer networking services which are both easy to use and accessible from nearly every location on campus. Results of the first year's study on usage patterns and user satisfaction indicate widespread acceptance and satisfaction with the system.

INTRODUCTION

A number of universities are engaged in the development of campus-wide computer networking systems that combine the power and storage capacities of the mainframe computer with the ease of use of the personal computer. Project Athena at Massachusetts Institute of Technology (MIT) has received corporate sponsorships to explore the uses of computers and networking technologies in the college curriculum (ref 1). Project Andrew at Carnegie-Mellon University (C-MU) is another massive attempt to produce a distributed personal computing environment that can serve as a unifying presence in its educational, administrative, and social life (ref 2). These developmental efforts are based on workstations with a cost approaching $10,000 each. Another experiment with campus networking, based on low-cost personal computers as the primary workstation, is occurring at Lehigh University in cooperation with Zenith Data Systems, IBM, InteCom, and the IBM-funded McGill University MUSIC Product Group. The goal of this project is to provide the Lehigh campus of over 7,000 students, faculty and administrators with microcomputer-based networking services.

COMPUTING ENVIRONMENT

Lehigh University is a private, coeducational university located in Bethlehem, Pennsylvania. Lehigh enrolls approximately 4,400 undergraduate and 1,900 graduate students, and offers baccalaureate, masters, and doctoral programs in four colleges, encompassing branches of the arts, humanities, social sciences, business, engineering, science, and education.

Lehigh's Computing Center houses five mainframe computers representing CDC, IBM, and DEC. These support general research and instructional applications, plus administrative computing. Approximately 500 communication ports, predominantly asynchronous, are distributed among these machines. Other department-run computer systems include a GEAC library system, and six other mainframes from IBM, DEC, Data General, CDC, and Harris, which together supply an additional 230 communication ports.

In addition, there are over 2000 microcomputers on campus, plus a selection of high-performance workstations. Each faculty member was provided with a MS-DOS compatible micro containing at least a 10 megabyte hard disk drive, 512K of memory,

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[1] Lehigh University, Computing Center Bldg. 8-B, Bethlehem, PA, 18015, USA

serial and parallel ports, and a color monitor. Six campus instructional laboratories contain a variety of microcomputers and minicomputers. Over 240 micros at public sites are available to students, faculty, and staff, who may also purchase them for under $1000 from the campus computer store.

USER APPLICATIONS

The process of selecting networking technologies included an assessment of the university's current and future user application needs. The initial requirements for the campus-wide communications network were:

- Replacement of overloaded campus telephone system.
- Centralization of campus electronic mail.
- Advanced manuscript and graphics printing capabilities.
- Bulletin board and electronic conferencing facilities.
- An electronic software library.
- Calendaring and scheduling facilities.
- High quality print and plot services.
- A centralized gateway to data networks.
- A common interface for connecting campus computers.

LEHIGH'S NETWORKING SOLUTION

Lehigh installed a digital PBX to solve its initial networking needs. The vendor selected was InteCom, Inc. The installation of the digital PBX solved the voice problem, addressed most current workstation communication requirements with 19,200 bps asynchronous support, and also provided up to 1 megabit support for special applications. The InteCom IBX S/80 is a large, computerized, digital telephone system with the capacity for 8,192 ports, each of which can support simultaneous voice and data transmissions. Lehigh's initial installation had 4,100 voice ports (telephones) and 4,000 asynchronous data ports, 2,700 of which share ports and wiring. A digital telephone and a data port were installed in each of approximately 2,000 student housing rooms on campus. The remainder were installed in classrooms, laboratories, computing centers, and academic and administrative offices. Off-campus access to computing facilities is provided through a pool of 60 modems.

The second networking phase, currently in progress, involves installation of local area networks in lab and office environments, and a high-speed backbone network utilizing Proteon token ring equipment to support TCP/IP-based protocols.

ADDITIONAL HARDWARE AND SOFTWARE NEEDS

Implementation of the networking strategy required a decision on whether to use a single computer or distributed servers to support network activities. After putting together a preliminary requirements document and contacting several vendors, it was decided to use a single mainframe computer to act as the communications hub. This computer, called the "Network Server", would be available to the entire campus community, with accounts being opened by individuals on-line using their university IDs. It was also required that the microcomputer workstations function with both the Network Server and other campus computers. Since no vendor had a complete solution to our needs, the university entered into a developmental project with IBM and the McGill MUSIC Product Group to develop and implement a campus-wide electronic information system. An IBM 4381-13 computer was selected to act as the Network Server using the MUSIC (Multi-User System for Interactive Computing) operating system running under VM. The microcomputer software to be developed would run on any IBM PC or compatible, and provide easy access to all network resources.

The joint development project primarily involves the creation and evaluation of two specific user interface "shells". The Network Server interface, LUNA (Lehigh University Network Applications), provides a host-based communications environment, optimized for use with microcomputers, rather than terminals, as workstations. The microcomputer interface, TERRA (Transparent Environment for Remote Resource Access) provides access to a variety of supported computers and peripherals on campus in addition to the Network Server.

HOST INTERFACE

The Network Server interface was designed to meet the requirement of providing a centralized communication facility for the transfer of information between people. It was developed using the various utilities of the MUSIC operating system, which permitted the rapid prototyping and subsequent optimization of applications. The interface is a series of hierarchical menus starting with the main menu called LUNA. Consistency of keyboard definitions, screen navigation, and screen presentation were stressed throughout the design stage (ref 3). Keyboard definitions were designed assuming the use of MS-DOS microcomputers. Topic selection is done by entering the appropriate menu keyword, and standard function keys perform common operations such as help, scrolling, or exiting.

The most heavily used facility is electronic mail. Full local services are provided, as well as access to world-wide networks. In many cases, users have become as dependent on electronic mail as they had been on conventional modes of communication. In addition to a surprisingly high level of social interaction, one of the chief benefits seen has been the less constrained and more innovative communication between faculty and students. Researchers and administrators alike have found clear advantage in the use of this medium.

The other major facility under LUNA is the INFO sub-system. This is a hierarchically arranged collection of functions which includes: announcements, bulletin boards, electronic software distribution, schedules, databases, on-line surveys, service request forms, and special-purpose applications. In all, nearly 200 topic areas have been introduced in the first year, with considerable growth expected. There is an INFO administrator who coordinates and assists in setting up all services, but each service is maintained by the individual or group responsible for that service. Bulletin boards provide faculty an alternative to mail for communicating with large courses, and provide forums for other special interests, such as student organizations. Electronic software distribution makes a large body of public domain microcomputer software available. On-line forms make services such as equipment rentals and library reference resources more accessible.

Additional LUNA functions make common file operations available, including text editing, printing, listing, and directory maintenance. Text processing capabilities such as spelling checking and document formatting are also provided. File download and upload operations for transferring files to and from the microcomputer workstation are other communication-related functions within LUNA. While all functions are provided via menus, a command-oriented interface is available for experienced users.

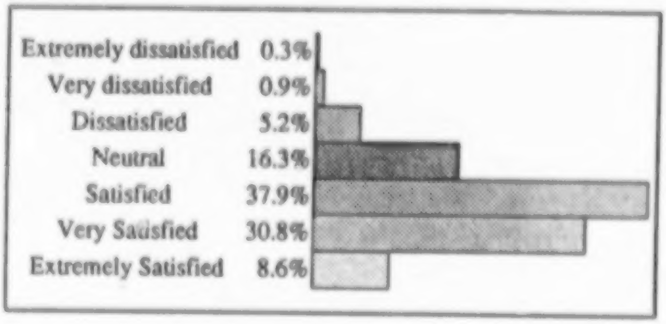
WORKSTATION INTERFACE

Considerable emphasis has been placed on developing the direct host interface in order to achieve early use and acceptance of the new facilities; however, the ultimate goal is to shift the user's focus from the host, back to the workstation. The development of the first phase of the workstation interface, TERRA, is at the point of user testing. The intention is to use the Network Server and other mainframes more as servers in the traditional sense, where their facilities are used as needed by the workstation without direct user involvement. This has been partially achieved in the current implementation. A user defines a personal workstation file which contains encrypted IDs and passwords for various hosts. Using these, TERRA is able to log into a specified host and simply begin terminal emulation, or, more to the point, engage in a dialog to perform other functions. Current examples include automatic file transfer (which can occur in the background) and automatic printing via the Network Server. Now under development are specific application interfaces, for example, a workstation-based interface to the electronic mail system, and an intelligent output services facility with conversion and formatting capabilities. Other work in progress will allow identical functions via high-speed networks, supplementing the present asynchronous connections.

SYSTEM USAGE AND USER SATISFACTION

The Network Server was opened to the Lehigh campus community January 14, 1987. The number of accounts by the end of the Fall 1987 semester was over 4500, or 64% of the possible user base. In November of 1987, the system averaged approximately 2500 logins per day with an average session length of 15 minutes. User satisfaction with the system was measured at the end of the Spring 1987 semester, with 581 people responding to a voluntary on-line survey of user satisfaction. The satisfaction survey was based on an instrument initially developed by Pearson (ref 4) to measure user satisfaction with information systems. Figure 1 shows that only 6.4% of the users responding to the survey were dissatisfied with the system, while over 77% were satisfied with the system. Females were found to be significantly more satisfied with the information system than were males (F=36.9029, p=.0000, df=1). Users associated with administrative and other non-academic departments were also significantly more satisfied than were users associated with academic departments (F=5.1176, p=.0005, df=4).

Figure 1:
User Satisfaction
Distribution



CONCLUSIONS

Lehigh University's experiment with campus networking is a massive commitment based on using low cost microcomputers as workstations. The campus network provides each member of the academic community with easy access to one another via an information system which is relatively user friendly. The rate of adoption has been excellent and overall usage trends indicate that a critical mass of users has been reached to insure the continued growth and acceptance of the system.

REFERENCES

1. E Balkovich, S Lerman, R Parmelee, Comm. of the ACM, 28, p1214-24, 1985
2. J Morris, M Satyanarayana, M Conner, J Horward, D Rosenthal, and F Smith, Comm. of the ACM, 29, p184-201, 1986
3. M Mushet, Jour. of Info. Sys. Manage., 8, p162-184, 1987
4. E Bailey, S W Pearson, Manage. Sci., 29, p519-29, 1983

A STRATEGY FOR THE EFFECTIVE INTEGRATION OF EDUCATIONAL SATELLITE APPLICATIONS

J F MURRAY*

ABSTRACT

There is recent growing interest within the UK in the educational use of satellites. Broadcasting within the UK developed through a land based transmission system in a public broadcasting service tradition. Educational expectations are influenced by this and are important factors in developing an integration strategy. Satellite offers a range of possibilities in remote sensing and TVRO applications. There is also the prospect of active participation in the Olympus programme. Successful integration of satellite applications depends on adequate staffing and funding and an independent objective evaluation programme. Such a programme, while recognizing inherent UK difficulties, should be capable of supporting planned development projects, basic information provision and staff development needs.

INTRODUCTION

If the micro-electronics revolution has been the most significant technological development over the last decade, "communications" may well be the main focus of attention during the next. Communication satellites represent one major link in the world's developing communications infrastructure. They are already used extensively to carry sound, television pictures, text and data.

Within the UK, there is increasing evidence of interest in satellite technology within the Educational System. Some schools have bought dish antennae to receive signals from commercial satellites. Others have bought equipment to download information from remote sensing satellites. Higher Educactional Institutions are feeding satellite delivered programming into Modern Language and other courses. To date, however, development has been piecemeal. No overall concerted policy or strategy has been adopted.

The UK is coming to satellite rather later than many other developed and indeed developing countries. It has things to learn from the experience of these other countries, but lessons cannot be imported and applied directly. The use of satellite within the UK must be seen against the wider backcloth of the history of broadcasting here. Any strategy geared to encourage sensible educational use of satellites must take this into account.

BROADCASTING IN THE UK

For the first half of the twentieth century, the Broadcasting System within the UK was in the hands of one independent body. Technological constraints were partly responsible and it was natural enough that scarce communication resources should be centrally controlled. The BBC, although largely successful in remaining free from political influence, was dependent on government for finance and continuation. The philosophy was very much that of a regulated system of public service.

BBC radio provision was supplemented by the beginnings of a Television Service in 1936. After the Second World War, this pilot service developed. The state of the art technology at the time of this development, coupled with the relatively small land area of the UK ensured that a land based transmitter system was engineered. By the early and mid-fifties, most people in the UK were able to receive a Television Service of reasonably high technical quality.

The advent of Television led also to the breaking of the monopoly. The creation of the Independent Television Authority (now the IBA) in 1954 reflected general post-war movements away from a central control and consensus model to one which extended more resources and power to a greater diversity of groups within society. The pirate radio stations in the sixties were the beginnings of this demand for diversification, deregulation and decentralisation and every successive piece of broadcasting legislation in the UK has moved the system slowly in this direction.

However, broadcasting developments in the UK took place within a well established land based transmitter technology when broadcasting by satellite and distribution by cable systems became realities in other parts of the world. The system was entirely appropriate to the needs of a regulated Broadcasting System with its roots in public service. It is relatively recently that the UK has had to face up to the realities and consequences of the explosion of Broadcasting channels and in particular Broadcasting by Satellite.

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EDUCATIONAL BROADCASTING

Educational Broadcasting within the UK is almost as old as Broadcasting itelf. The BBC chose to interpret its remit to "inform, educate and entertain" by providing, early in its history, a sector of programming aimed directly at schools. Since the 1920's, the Educational System has been closely involved with Broadcasters to produce a substantial educational output for schools and, increasingly, adults. The Independent Television companies were bound by regulation to do likewise, thus extending the "public service" ethos to commercial concerns.

Thus, the Educational System within the UK has enjoyed a long tradition of commissioning broadcast resources, paid for by either Government or commercial companies, and having free access to such resources. Schools and other institutions have sets of expectations about broadcast resources deriving from long established traditional relationships with Broadcasters.

The video recorder in schools has been used primarily as a timeshift device for the management of off-air educational broadcasts. Again, it is only relatively recently that "off the shelf" video material from sources other than the Broadcasters has begun to make in-roads into schools and colleges. Even here, there is strong resistance to paying anything other than nominal costs. There is an expectation that such materials should be freely available.

In examining the potential of satellite in the UK setting, it is important to be aware that the Educational System, rightly or wrongly, will expect a similar kind of service to that it has experienced with traditional UK Broadcasting Organisations.

POTENTIAL OF SATELLITE

In the UK, there are three kinds of opportunity for educational applications utilising satellites. The first involves the downloading of raw data from remote sensing satellites; the second, often referred to as TVRO (Television Receive Only) involves reception of programme material transmitted from commercial and other national satellites; and the third is the opportunity for active participation through an experimental high powered satellite called Olympus.

Remote Sensing

This involves reception equipment capable of downloading raw data and information from remote sensing satellites for manipulation and interpretation with a microcomputer. Typical applications are within Geography or Science areas of the curriculum, where meteorological information and data is manipulated to form a weather map. Such applications encourage data handling and problem solving skills and dealing with first-hand raw data is a powerful motivational factor.

TVRO Applications

At present, though the area is subject to continual fluctuation, approximately 17 satellite delivered channels can be received within the UK from the commercial Intelsat and Eutelsat Satellites, with the aid of large dish antennae currently costing in the region of £1,200-£1,500. With steerable versions of this equipment, transmissions from other national satellites can be picked up (eg from Russia) depending on strength of signal and location within the UK.

Those immediately interested in such programming come primarily from the disciplines of Modern Languages, Modern Studies and Media Education, where the relevance of broadcasts from foreign countries is readily apparent. Such programme material possesses an authenticity over and above similar material "relayed" through the indigenous Broadcasting Service.

Active Participation

To date, the most significant opportunity for active participation in applications involving satellite comes through an experimental programme organised through the European Space Agency, around an experimental satellite called Olympus. Funded by a consortium of European countries and Canada, this high powered satellite is due for launching in February 1989. Olympus is a true DBS (Direct Broadcasting by Satellite) operation which transmits at a higher power so that its transmissions can be received by smaller dishes. Prices of these are predicted to be in the region of £300-£500, thus putting reception equipment within reach of individual educational institutions.

The prime purpose of Olympus is experimentation and exploration of new services. Much of its payload will be devoted to technical testing, but one of its two wideband broadcast channels will support, among other things, educational experimentation. Educational networks will have an opportunity for active participation in this scheme. SCET, for example, has negotiated an allocation of 20 hours per year to support Scottish experimentation.

The most significant feature of the Olympus programme is that educational concerns will have the opportunity to communicate in picture and sound, text and data, or a combination of these, with a potentially very wide audience both within the UK and wider afield in Europe. They will have direct access to a channel of communication presently the preserve of Broadcasting organisations. At the outset, therefore, Olympus offers the prospect of an *ADDITIONAL* channel of communication to the Educational System to support on-going educational work.

Secondly, the programme offers the opportunity to explore satellite transmission as an *ALTERNATIVE* delivery system which can be used to convey existing materials or messages to existing client groups within the UK or further afield within Europe. Point to multi-point applications (eg widescale distribution of software, A/V resources or Distance Learning Courses) are obvious areas for exploration, but there are undoubtedly others.

Thirdly, Olympus provides a framework within which to explore *NEW POSSIBILITIES*. This will include new kinds of educational programmes using multiple audio channels or datastream components for example, or introducing interactive elements. It will also include exploration of new educational applications not previously realisable because of the scarcity and inaccessibility of such a communication resource. New audiences and new messages are therefore a possibility right across the board, and the spectrum is likely to include international communication between schools as well as applications in Higher and Tertiary Education.

THE INTEGRATION OF NEW TECHNOLOGY

The possibilities that satellite broadcasting seems to offer to UK participants are exciting, but adequate support from Government and others is essential if these educational prospects are to be turned into a reality. A properly funded programme is therefore an essential requirement.

Within such a scenario, however, there is a general difficulty which must be recognised. Where technology has its roots in the commercial system, the profit motive can lead commercial entrepreneurs to make exaggerated claims on behalf of their technologies. Government interest is often high particularly when it has invested funds to support technological development. This may augur a vested interest in successful outcomes.

An important role for the ecuational technologist is that of an independent evaluator of technology. Increasingly, the only way to keep abreast of developments and monitor strengths and weaknesses of new technologies is to generate funding from those very parties with vested interest in success. This can create real psychological pressure to advocate rather than assess.

The pace of change also causes problems. The training of an educational technologist ties him to systematic, objective and analytic approach to evaluation, which is often a lengthy and time consuming process. The pace of change often means that standing still to evaluate one development leads to failure to keep abreast of other (perhaps more important) developments. A real tension can exist, therefore between the very legitimate desire to be thorough in assessment, but the equally legitimate desire to keep up to date.

These general background factors mean that any evaluation strategy must be both independent in its terms of reference, but staffed and funded to a level that will allow thorough and objective evaluation.

For the potential of satellite applications to be realised, there needs to be a clear strategy designed to achieve purposeful and effective integration of use. In this respect, the introduction of satellite technology gives rise to the same range of issues that other technologies have raised. There is a need to identify the strengths and weaknesses of applications of the technology; to test and evaluate its effectiveness and appropriateness; and to provide appropriate training and information support to ensure successful implementation of practice. Within the UK, there are a number of problems that must be overcome if this is to be successfully achieved.

Given the relative inexperience of the UK educational community with satellite technology, there is an acute need in the first instance for basic information on ground equipment. Only a very small part of satellite programming takes part in space - it is mostly a ground operation.

There is a need for basic information on reception equipment. Many UK users may be aware that the equipment required for remote sensing operations is different from that required for TVRO reception. Fewer will realise that present reception equipment is not compatible with DBS transmissions, and the situation is constantly developing and changing.

For those considering active participation, there are many technical and production issues (scheduling, formatting, coordination, information provision, uplinking, costing etc.) which relate simply to the mechanics of programme provision. Here, there is much to learn from other countries - as there is about programme and course design and the kinds of applications that are most likely to bring benefit.

There is the need to be aware of the significant factors in the educational setting into which satellite technology is being introduced. Within a strong tradition of public service educational broadcasting, there is an expectation that transmitted resources will be "free" and supported with appropriate documentation and information. Within TVRO applications, very little of the current output is earmarked as educational. Not all of the transmissions are free. There is a scarcity of detailed programme information. Successful use of satellite programming therefore requires a realistic examination of what is actually on offer, and some change in attitudinal set on the part of the user.

The same attitudinal change is required in Active participation settings. Whereas access to Olympus is "free" for users, the costs of programme production, coordination, information provision etc. must be met by the educational community in one form or other.In addition, it is unlikely that education will enjoy completely free access to the satellite for more than a few years and so there will eventually be transmission costs at some level. In the present climate, the educational world is facing increasing pressure to pay directly for the resources it uses, and if it wishes to take advantage of the opportunities afforded by satellite, it must take on board the costs in the long term. Cost effectiveness of satellite applications is therefore of central concern.

Much satellite usage will simply replicate and on occasion exacerbate the problems currently experienced by those using existing broadcast information (curricular relevance and integration, management of resources etc.) and reinforce the need for appropriate staff development. The educational world in the UK has had 30 years to get used to educational television broadcasts (60 years for educational radio programmes) and yet an examination of much current practice reveals a continual need for training and examples of good practice.

SUMMARY

The basic elements of a strategy to manage the effective integration of satellite applications are:-

A The creation of a project within the framework of a central independent body.

B The provision of sufficient funding and staffing to support the following activities:

1. Research into the experience of others in other parts of the world in order to inform use by UK participants.

2. Provision of an advice and information dissemination service on basic technical and equipment aspects.

3. Provision of reception equipment for a range of TVRO and Remote sensing applications as a basis for evaluative projects designed to produce, where relevant, appropriate case studies, exemplars and staff development materials.

4. Management and funding (at least partly) of a series of active participation projects designed to identify the most effective procedures for coping with the mechanics of production and to evaluate the effectiveness of such programming for the end user, with special attention payed to cost-effectiveness.

5. Provision of a general awareness raising function through seminars, conferences etc. and provision of specialist seminars and training sessions where appropriate.

6. Provision of a forum for users and practitioners to share information and experience.

WHAT IS OPEN LEARNING

NIGEL PAINE, SCOTTISH COUNCIL FOR EDUCATIONAL TECHNOLOGY

THE KEY ELEMENTS OF OPEN LEARNING

Open learning is concerned with two primary objectives:

* *providing student centred learning opportunities for learners*

* *widening access to learning to those effectively excluded from current educational and training opportunities.*

The former deals with the PROCESS skills of learning: creating a positive attitude to learning; helping learners to continue to learn and take control of their own learning destiny, and the PRODUCTS of learning. The skills should be relevant, the content based around the learners needs and the learning delivered in the most appropriate way for the learner.

The latter concerns itself with overcoming barriers for the learner. These can be physical barriers where the time, place and pace of traditional opportunities are inappropriate or attitudinal where the way in which traditional learning presents itself excludes sections of the post-compulsory population from attempting to return to learn.

THE CONTEXT

Britain is living through an era of unprecedented change industrially and socially. Since 1979, for example, Scotland has lost one third of her manufacturing jobs. Every aspect of the working world is being influenced by the need to adapt to new technology, to devise new products and new services to cope with a changing world, and we are doing that with the smallest percentage of young people coming onto the job market for decades.

By the year 2000, all our jobs will have changed radically. Many will not only have to adapt their existing roles to changed circumstances, but change career completely, perhaps more than once. Yet in Britain, 70% of today's workforce will still be working in the year 2000. The need to dramatically increase the quality and the quantity of learning for adults is clearly demonstrated, but the existing post compulsory education and vocational training provision is geared largely to pre-service work.

OPEN LEARNING AND DISTANCE EDUCATION

The concept of distance learning has existed far longer than the relatively new concept of open learning. This causes a certain amount of confusion and rivalry between the two camps. It would be helpful to distinguish between them by looking at one or two recognised and well known quotes:

"'Open Learning' is a term used to describe courses flexibly designed to meet individual requirements. It is often applied to provision which tries to remove barriers that prevent attendances at more traditional courses, but it also suggests a learner-centred philosophy. Open learning courses may be offered in a learning centre of some kind or most of the activity may be carried out away from such a centre (eg, at home). In nearly every case specially prepared or adapted materials are necessary."

What Is Open Learning? CET Guide 4
Roger Lewis and Doug Spencer

"'Distance Education' is a generic term that includes the range of teaching/learning strategies referred to as 'correspondence education' or 'correspondence study' at further education level in the United Kingdom; as 'home study' at further education level and 'independent study' at higher educational level in the United States; as 'external studies' in Australia; and as 'distance teaching' or 'teaching at a distance' by the Open University of the United Kingdom."

The Foundations of Distance Education by Desmond Keegan

What we have is a clearly defined academic tradition which has asserted its autonomy from the traditional higher education provision. The amount written, for example, on the British Open University, exceeds the total literature on all aspects of open learning by a factor of ten. Yet the basic definitions of distance education will simply not "fit" the variety of opportunities which come under the heading of open learning.

THE CHARACTERISTICS OF OPEN LEARNING

* Learners are often homogeneous, coming from a tightly defined target group or living in a clearly defined georgraphical area.

* Contact can be fairly intense between learners, and most learning may take place in a learning centre.

* Courses can be relatively short leading to no formal qualification.

* Sometimes only one learning mode is used eg working in an Open Access Centre or learning in small tutorless groups from a learning package.

* Flexibility is the key. A learning system can be put together to suit both the needs of the learner and the resources of the providing institution.

* No fixed model to apply.

THE CHARACTERISTICS OF DISTANCE EDUCATION

* Students come from widely dispersed target groups.

* Minimal contact between groups of learners and tutors and learners.

* Courses lead to qualifications and are mainly higher level.

* The learning is based on a combination of learning modes:

  - working with specially prepared packages alone usually at home;
  - attending occassional tutorials at an appropriate centre or joining in a telephone conference with fellow students and tutor;
  - attending a weekend or summer school which involves a residential block for intense practical or academic work;
  - assessment by correspondence comments on assignments;
  - formal end testing leading to a qualification.

* Fixed model, defining procedures clearly.

SUMMARY

Distance learning defines a clear process for extending learning opportunities. It is designed to bridge distance, and thereby allow learners who cannot attend a conventional institution to nevertheless access learning opportunities.

It grew from the need to provide adults with access to qualifications and flourished in the wake of the broadening of qualification opportunities.

In Britain, the introduction of competitive examinations for entry into the Civil Service gave the early impetus to distance learning in the late nineteenth century.

More recently the Open University offered degree level qualifications to adults who could not take three years out from their careers to attend a conventional University.

Distance learning will flourish where a widely dispersed group of potential learners need access to structured learning opportunities.

Open learning is a broader brush concept which does not necessarily specify the model but specifies the approach. It takes as its starting point, not distance, but the needs of the learner. From this an appropriate learning system is devised. It is a systems approach to innovation in learning and can therefore accommodate a wide variety of models.

VARIETIES OF OPEN AND DISTANCE LEARNING

To give some idea of the range of possibilities opened up by this model of learning, a series of quadrants can graphically illustrate the breadth of schemes which move from traditional provision to both open and distance learning.

Quadrant One

traditional locations *traditional methods*	*new locations* *traditional methods*
traditional locations *new methods*	*new locations* *new methods*

In the first corner lies the majority of existing provision. It is both traditional in terms of where learning is offered and in the learning methods used. Each of the three other corners illustrates some kind of innovation. Corners 3 and 4 could well incorporate open learning elements.

In corner 2, traditional learning methods are offered in new locations very much in the same spirit as the extra-mural class or newer ideas which take education into industrial locations. Not really significantly open or distance learning here.

In corner 3, however, the existing institution may well demand attendance of its students but the methods it uses are new and innovative. There is much potential for open learning here but very little distance learning as such.

Corner 4 incorporates both open and distance models. Learning is taken out of the traditional institution by the institution itself or by setting up a new institution to accommodate the new delivery methods. The British OU falls into this category.

ISBN 0 905941 28 4 Two Vols
0 905941 26 8 Vol 1

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